POWER

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Use the Water—Save the Coal

IN HIS contribution to the Power-plant Symposium in the December 4 issue Thomas E. Murray made a sagacious remark.

After having expressed the belief that in many cases the saving in fuel does not warrant the money that is being invested he said:

"However, we should endeavor to conserve the nation's resources so that future generations should not be deprived of the comforts and facilities that we have today."

The thought had come to me in listening to a discussion upon the comparative cost of steam and water power.

It was urged, and perhaps demonstrated, that it was not worth while to develop a large amount of water power that was running to waste because the power could be developed more cheaply, under present conditions, by burning coal.

But when we burn coal, we are using up an irreplaceable resource. What are we using up in the case of the water power?

Nothing but money.

We can make more money but we cannot make more coal.

During the lifetime of a hydro-electric plant the users of its product will have to repay, in installments through depreciation, the capital invested and interest year by year upon the portion still unpaid.

I have an idea that when the more developed world comes to look with the perspective of the historian upon the way we settle this question, the people of this day and generation will be soundly blamed if, in order to save a few dollars in investment and interest, we draw upon the stored-up fuel of our planet for power that could as well be furnished by falling water.

The earth can absorb only so much energy from the sun. One way that it absorbs it is by the evaporation of water, another by the photo-synthetic processes by which fuel is made.

It is doubtful if it can absorb enough by the latter method to meet our growing demands for power, even with intensive methods that may be developed.

The day will come when the fullest use will be made of the first method, and the sooner we get at it the farther off will be the day when the world will suffer for the want of the products of the large-scale use of heat.

J. R. Low

The Year's Contribution to Power-Plant Progress

Sustained Activity in New Plant Construction—Heat Cycles Widely Discussed in Connection with New Designs—Extensive Power Studies Being Made—Political Controversy Holds Up Important Hydro Developments—Powdered Fuel Shows Big Gains

AT THE beginning of 1923 many, including several of the so-called business forecasters, predicted serious inflation, to be followed later in the year by a slump with all its attendant evils, including unemployment. Instead, industry, by hard work and close attention to details, has been able to maintain a fairly steady pace, spotty in certain sections owing to local conditions, but on the whole satisfactory and with little labor trouble.

The demand for power continues to increase throughout the country, and construction, especially among the central stations, has been active. Work on those plants projected toward the close of last year has gone steadily forward and several important stations have been completed or are nearing completion. Other large stations have been planned during the last twelve months, and construction upon them will begin early this year. Plans for a new large steam station in California to supplement hydro-electric power have just been announced. In the industrial power-plant field new construction has not been quite as marked, although by no means has it been at a standstill.

Superpower is still discussed, and many of the engineering details have been worked out. Some of the legal barriers, however, have not yet been overcome, and this phase of the problem is now being studied, and the government, through Secretary Hoover, is endeavoring to use its good offices to bring co-operation among the states concerned. Closely related to this problem is that of certain large undeveloped water powers which are temporarily held up because of political considerations.

New England Power Being Studied

The power situation in New England presents a problem of its own. Owing to the labor differential in favor of the South and hydro-electric power there available at a reasonable price as contrasted with the more expensive labor and high prices of coal, subject to interrupted supply as obtains in New England, the bulk of new mill construction has during the last few years shifted to the South. Moreover, except in some of the larger mills, there has been a reluctance to spend money to modernize the power plants of many of the smaller mills with the result that some have gone over to central-station service. One large central station is now being constructed at Boston, and another is about to be started near Fall River to help handle the increasing industrial load.

However, wages in the South have lately become higher, and in some sections the power load has almost reached the saturation point of present development. Additional hydro-electric development will be more expensive and necessitate higher rates. These two factors combined may again throw the balance in favor of New England, providing sufficient reliable and continuous power is available in that section at a reasonable price. In anticipation of this a study is now being made of the diversity of the flow as between the water powers of New England and those of the Province of Quebec. Indications are that the diversity is such as to insure by interconnection a continuous and adequate supply to New England industry. Vast developments are now being made in the Canadian province, and if obstacles do not come up to prevent the export of part of this power during the next few years, the power supply of New England may be solved for some time.

In Pennsylvania Governor Pinchot has appointed a committee to make a giant power survey of the state with a view to determining the most suitable centers of generation and distribution in order to meet the growing industrial and agricultural needs.

Production of Bituminous Coal Adequate

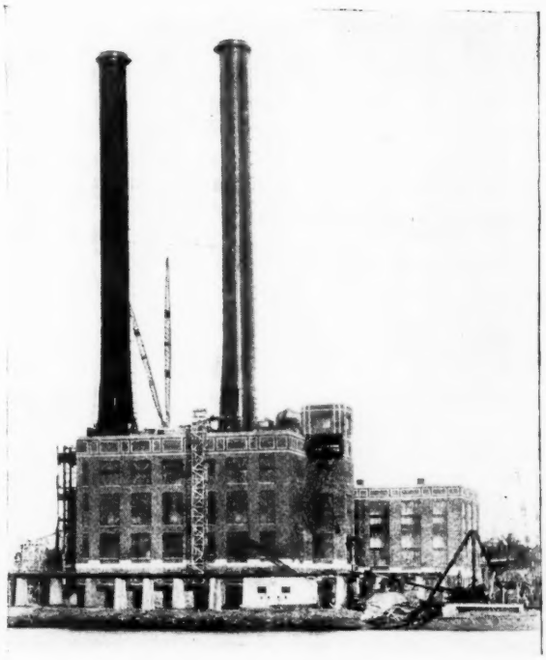
In the coal fields generally there have been a number of interesting developments. With an ample supply of cars and no labor troubles the production of bituminous coal has been high, reaching by December 506,813,000 net tons, as compared to 365,437,000 tons for the same period of 1922 and 540,196,000 tons for 1918, when production exceeded all past or succeeding records. With an average of nine million tons per week for December, the total production for the year should exceed 540,000,000 tons. Storage has been heavy, reaching at the present writing nearly 80,000,000 tons. Maximum production for the greater part of the year has created a buyers' market. The average spot price at the mine for the entire country has been dropping, reaching $2.19 per ton of bituminous in December.

For the first seven months of the year the anthracite production was the greatest on record. The short strike interfered temporarily with the working of the mines, but by Dec. 1 the output had risen to 88,204,000 net tons, which at a weekly rate of two million tons for December should bring the total for the year close to 96,000,000 tons. Unlike the bituminous, the price has advanced 50 to 75 cents per ton at the mine to cover the 10 per cent raise in miner's wage awarded.

Although the coal situation is such as to insure an adequate supply during the winter months, the condition is generally regarded as only temporary, with the possibility of further interruption when the present agreement with the soft-coal miners expires in the spring. Much was expected from the Federal Coal Commission, and its report was a disappointment to many who felt that, although it had compiled a vast amount

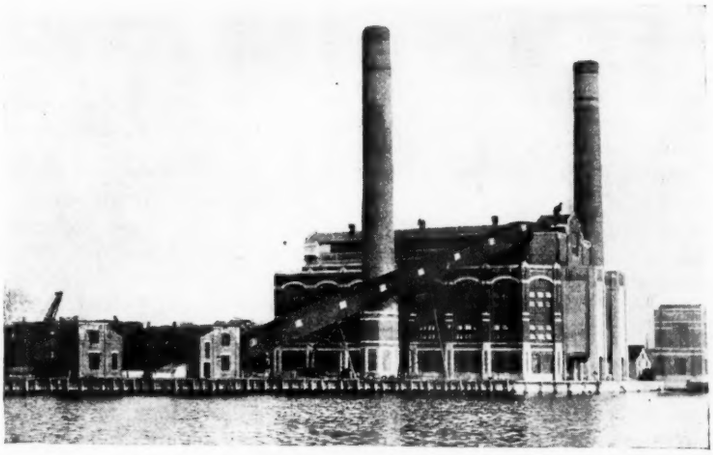
Initial Sections of Four New Plants

Left — At Saxton, Penn., the Penn Central Light & Power Co. has built a mine-mouth plant that will have an ultimate capacity of 100,000 kw.



Above—Barbadoes Island Plant of Counties Gas & Electric Co. Initial capacity, 40,000 kw.; ultimate capacity 120,000 kw.

Right—Steel Point Station of United Illuminating Co., Bridgeport, Conn.



Above—At Devon, Conn., the Connecticut Light & Power Co. is completing a 100,000-kw. plant; the ultimate capacity will be 200,000 kw.

of information, it had failed to crystallize this into any definite conclusions. To what extent Congress will legislate on this report will likely depend on the disposition of other matters now occupying the attention of that body. Meanwhile, Governor Pinchot of Pennsylvania has attempted to find a solution to the anthracite situation through state action.

The periodic disturbances in coal supply, with their accompanying increases in price, have done much to focus the attention on water power, to stimulate the use of fuel oil and powdered coal and to awaken the consumer to the necessity of providing adequate storage. Only recently, a whole session of the A.S.M.E. annual meeting was devoted to the consideration of coal storage, and a committee of the Federated American Engineering Societies has been actively engaged in making an investigation and report on this subject, and various local associations have been discussing it at their meetings.

Increased Use of Fuel Oil and Pulverized Coal

Overproduction due to the ever-increasing demand for gasoline, vast quantities of oil in storage and low prices, summarize the situation in the oil field. The last named factor has stimulated the use of this temporarily cheap fuel in the boiler room and has resulted in numerous changes with profit from coal to oil. Not alone in New England is oil fuel making great headway, but a considerable number of new buildings in New York City as well as in Philadelphia and other sections are adopting it. Its use for heating boilers is also increasing. With the close of the year declining production points to an early return to the normal situation where a definite balance must be imported to meet the constantly increasing demand.

In the pulverized-coal field there has been great activity. The inherent advantages of high maintained economy, flexibility, the ability to utilize variable grades of coal, the elimination of clinkers by the oxidation of the sulphur and other factors, have been accepted, particularly for stations having high load factor, and many new installations are going in. A number of the largest and most recent central-station plants are being equipped to burn pulverized fuel, steel plants are patterning after the River Rouge installation of the Ford company and are equipping to burn in combination powdered fuel and blast-furnace gas, a variety of smaller industrial plants have adopted this method of burning coal, and a surprising number of existing plants are trying out one or two boilers with this fuel to determine the system that will fit in best with their particular conditions. One large central station that has been burning fuel oil for several years is trying out powdered coal under one or two boilers and will have splendid opportunity to obtain comparative results under identical conditions. The large production of inferior coal at comparatively high prices and the variation in quality prevalent in recent years, no doubt has served to stimulate this movement. As an indication of its magnitude figures are available to the effect that since the first of the year contracts have been placed for powdered-coal equipment to serve 1,300,000 sq.ft. of boiler-heating surface. Other data giving some idea of existing installations, estimate the amount of coal pulverized in the United States and Canada during 1923 at 17½ million tons.

With it all the art of burning coal under boilers in pulverized form is still in a state of flux. There is no such thing as a standard installation. Each plant has its distinctive features, varying as to the method of handling and feeding the fuel, furnace and burner design, type of pulverizer employed and the fineness of grinding, the amount of drying considered necessary, the construction and arrangement of the water screens in the furnace, the location of the superheater in the boiler, etc. With all kinds of fuel and the wide diversity of conditions this is to be expected. From the great variety of new plants going in, however, the data that will be available should clear up many points at issue. Generally, there is a decided tendency toward more compact and less costly fuel handling and preparation plants, larger and more efficient pulverizers are being developed, drying with flue gases is proving satisfactory, furnace walls are being ventilated to preserve the brickwork and preheat the air for combustion, and refractory material is being perfected that will reduce the amount of excess air needed for cooling and permit considerable reduction in furnace volume.

Although the stoker now has a commercial competitor that is rapidly developing, the fact that over 12,000 stokers serving more than 6,500,000 sq.ft. of boiler-heating surface, were sold during the first nine months of the year, would indicate that it is still very much in the running. More than this, when the stoker is given the same advantages early accorded to the powdered-coal plant, the results obtainable will be improved and its position more solidly entrenched.

For the low-temperature distillation of coal, some thirty different processes are under consideration and progress is being made. The advance in this country is represented by the installations at Huntington and at the Ford plant, details of the latter having appeared in a comparatively recent issue. For these installations the outlook is promising, but developments have not progressed to the point where commercial success is assured.

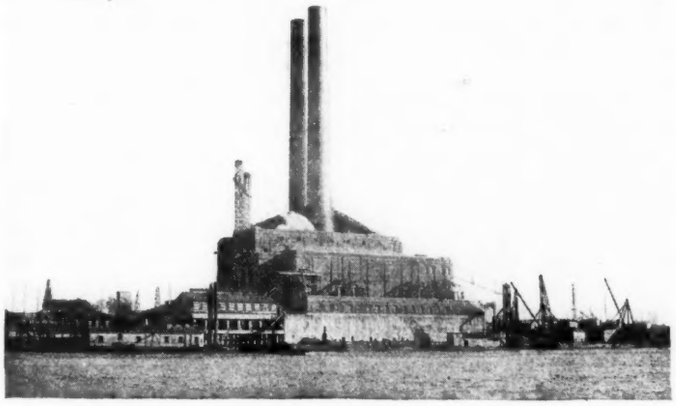
Along somewhat similar lines are the lignite carbonizing experiments conducted at Grand Forks by the United States Bureau of Mines and the University of North Dakota. A report on this work was issued early in the year. The production of a well-carbonized lignite was the problem, without for the present attempting to recover the byproducts, gas and tar. To make briquets an artificial binder would be necessary, adding to the cost, so that it is proposed to find a market for the lignite char direct. A simple inexpensive oven has been devised to produce the char. About 2½ tons of the raw lignite reduces to one ton of char containing 12,000 B.t.u. per pound. It is low in moisture and can be stored without danger of fire or degradation in size. Another low-grade fuel to be investigated by the Bureau is peat. An appropriation is available, and it is probable that the work may begin during the winter.

Heat Cycles Receiving Close Attention

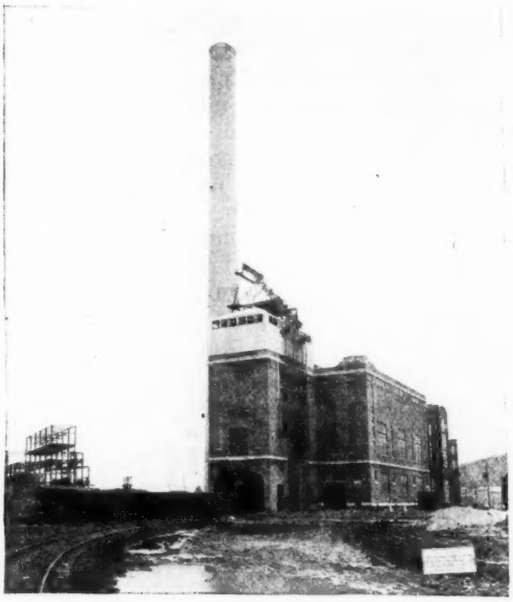
During last year all sorts of facts, theories and ideas that have for years lain dormant in textbooks have come to life, demanding immediate recognition. Remarkable openmindedness has been exhibited by the profession toward these "innovations." Whether it be 1,200-lb. steam pressure, the mercury turbine, or reheating between turbine stages, every suggestion of theoretical merit is being given serious attention.

The innovations mentioned in the preceding paragraph are among those upon which expert opinion is still divided. There is general agreement that the pre-

Right — Cahokia Station, St. Louis, operating on powdered coal



Below — Hudson Avenue Station of Brooklyn Edison Co. nearing completion.



Above—Initial unit of Pine Grove Station, East Penn Electric Co., which will have an ultimate capacity of 200,000 kw. A 498x 250-ft. cooling pond is employed.

Left — Waukegan Station, Public Service Co. of Northern Illinois.

Some Steam Plants Recently Completed or Nearing Completion

dicted fuel economies will be substantially obtained, but the commercial feasibility is still questioned. This questioning does not take the form of opposition, but is merely an attitude of waiting to be shown, with a general readiness to accept the innovations as soon as their value is well established.

In any list of relatively new developments mention should be made of bleeder heating. This method of operating is, however, in a different class from the items just mentioned. No difficulties of importance were to be expected and none was encountered. As a result bleeder heating is already an accepted practice, adopted without question for most new large plants.

The air preheater has for some time received favorable consideration, but practically no commercial installations had yet been made in this country, possibly because little attempt was made to market such devices here. Theoretical considerations favor the air heater for high-pressure bleeding cycles, and good reports have been coming in from Europe for a couple of years. These favorable indications are now reinforced by the recently published report of the first comprehensive preheater test made in this country. The test, made this summer at Colfax, appears to have been highly satisfactory. Several installations are now being made.

The heat-cycle papers presented at the annual meeting of the A.S.M.E. in December (together with the points brought out in discussion) indicate the trend of engineering thought. The consensus of opinion seems to be that the Rankine cycle is losing ground rapidly. High-pressure plants, in particular, can hardly hope to justify their greater cost by the slight efficiency gain they show with the Rankine cycle. The bleeding (regenerative) cycle, combining good efficiency at high pressures with operating simplicity and reasonable first cost, seems to find the most favor just now. The advantage of the bleeding cycle over the Rankine increases with the pressure.

High pressures likewise increase the desirability of reheating. With reheating, steam at initial high pressure and moderate superheat becomes saturated at an early stage in the expansion, with resulting lowered efficiency in the later stages. Opinions differ as to the relative commercial economy of bleeding and reheating, but many engineers feel that a combination of the two would, in certain cases, be better than either alone. The fact remains that from the operating point of view bleeding is much better established than reheating.

It has been suggested that moisture separators be incorporated in the turbine casing at the bleeding points. Moisture removal would take away one of the chief reasons for reheating. On the other hand, bleeding of steam up into the superheated region—another suggestion—would remove the objections, brought against the combined cycle, that reheating reduces the possible range of bleeder heating.

As to pressures, it appears mechanically feasible to build boilers, turbines and other apparatus for 1,200-lb. and higher. However, with present costs of fuel and apparatus, some engineers see no appreciable commercial gain in going above 800 lb. under base-load conditions. This is for a maximum temperature of 750 deg. F., which seems to be the practical operating limit with present materials. When new materials make higher temperatures practicable, the economical pressure should likewise go up.

Boilers and Boiler Auxiliaries

Heavy Demands Accelerate Normal Development—Spectacular Pressure Increases—Changes in Baffling and Superheaters—Novel Furnace Designs—Air Heaters—New Instruments

DEVELOPMENT in this department of the power plant during the last year has been greater and more diversified than ever before for an equal period of time. The building program has been enormous, radical departures from previous practice have been made in the design and arrangement of auxiliary equipment, two new steam cycles have been adopted, and to improve thermal economy steam pressures up to 3,200 lb. are under consideration. In fact, it would look as if an attempt was under way to crowd into a short period the normal development held up for the previous nine years by the war.

Of the various factors the proposed increases in pressure are the most spectacular. Theoretically, any increase in pressure over present practice will improve the economy, but the possible gain of an additional rise decreases as the pressure advances, while the cost and complications increase. Metals in use at present have definite temperature limitations, for the higher pressures many engineers regard interstage reheating as essential, and there are other complications that will have a bearing on what may be the most economical pressure to use. Actual operating experience over a period of time will be the deciding factor, and the economic balance may swing in one direction or the other, depending upon the results secured and the success with which the numerous obstacles are overcome. Then again, the type of plant, the number of hours of service and the load factor will enter into the decision, so that, much as it is at present, two different standards will develop, one for the base-load plant that can earn returns on a greater investment and another for the plant of relatively low load factor, such as the average industrial installation.

A year from date some of these data may be available, for in three different plants in this country large boilers designed to operate at 550 lb. pressure and at temperatures up to 750 deg. F. are going in. With these installations the design is not very different from that of boilers already in service and operating at 400 lb. pressure. Within the year valves and fittings for pressures over a wide range have been standardized, and as the boilers are going in base-load plants, carrying uniformly steady loads, the reheating problem will be simplified.

What may be termed experimental installations operating on commercial load are the boilers designed for 1,200 lb. for the Weymouth station of the Edison

Electric Illuminating Co., of Boston, and the Chicago installation at the Calumet plant of the Commonwealth Edison Co. A cross-section of this boiler has appeared in these columns. It will be recalled that the boiler is of the inclined-header, cross-drum type with upper and lower decks of 2-in. tubes, separated sufficiently to accommodate a primary and secondary superheater, the latter for reheating the steam exhausted from an extra high-pressure turbine before delivery into the main header. More recent announcement has been to the effect that the resuperheater, formerly enveloping the primary superheater, has been moved to a location above all the tubes so that the flow of gases past the reheater may be controlled to give accurate regulation of the reheat temperature. With no baffling in the lower deck of tubes and a single baffle in the upper deck, the gases are discharged midway of the boiler height into a contraflow economizer, so that a compact and convenient installation with the boiler high up to give large furnace volume and maximum exposure to the radiant heat of the fire is obtained.

Foreign Designs for High Pressure

From Berlin news comes of a German boiler designed to generate 15,500 lb. of steam per hour at a pressure of 850 lb. gage. Delivery is to be made to a reciprocating engine driving an air compressor, the exhaust at 140 lb. pressure flowing into a heat accumulator supplying the steam hammers of the shop. The drums of the boiler are forged from one piece of metal without welded or riveted joints. To relieve internal stress, they are annealed after forging and in the boiler are protected from the hot flue gases. The design of the boiler had been based on experiments of W. Schmidt, who, with a test boiler constructed in 1910 for this pressure and a quadruple-expansion condensing engine equipped for intermediate superheating, had developed an indicated horsepower-hour on 5.8 lb. of steam, as compared to 8.8 lb. with the same equipment under an operating pressure ranging from 215 to 285 lb. gage.

For about two years a Swedish boiler designed for 1,500-lb. pressure has been operating with success at 900 lb. It is designed along entirely original lines. Steam is generated from centrifugally formed shells of water in rotating tubes 12 in. in diameter and, it is claimed, at a rate of evaporation ranging from 60 to 100 lb. per hour per square foot of heating surface.

It remained to conservative England to exceed all previous efforts with the Benson super-pressure plant, which is to generate steam under critical conditions at 3,200 lb. per sq.in. and a temperature of 706 deg. F. At the critical point steam and water have the same properties—that is, the same density, the same heat content, etc.—so that in the transition from water to steam there is no latent heat to add and no boiling. A steam generator with heating elements of small section without steam drums is thus permissible, and an experimental test plant of this character is being built for the English Electric Co. at Rugby. Its capacity will be equivalent to a 1,000-kw. commercial plant. Steam will be generated at 3,200 lb. per sq.in., then throttled to 1,500 lb. and, after being superheated to 788 deg. F., will be passed through a high-pressure turbine exhausting at 200-lb. pressure. The exhaust will be reheated to 662 deg. F. and then expanded in a standard turbine and condenser to 29 in. vacuum.

As pointed out previously, one of the factors tending to hold steam temperatures below the point to which it may be desirable to go, is the materials available. Already the limits of present metals have been reached, so that a medium with a lower vapor pressure than that of steam at the temperatures involved, is desirable. Mercury is such a medium, and since 1914 the progress of the Emmet mercury boiler and turbine has been watched with interest. Fifteen designs of boiler have been constructed to date, and recently a unit has been placed in commercial service at the Dutch Point Station of the Hartford Electric Light Co. At 35-lb. gage and 812 deg. F. the mercury is vaporized and in a special mercury turbine is expanded to 29-in. vacuum and 414 deg. F. The condenser is a steam boiler which may operate a conventional steam turbine or supply the steam to the main header. The boiler is oil fired.

Compared with an efficient steam-turbine plant operating at 200-lb. pressure, the mercury-steam combination should give 52 per cent more electrical output per pound of fuel, and if the same turbine plant were equipped with the mercury apparatus, for 18 per cent more fuel the station capacity would be increased about 80 per cent. Over a steam plant employing higher pressures and utilizing the extraction cycle, the gain would be reduced, but there would be still a margin in favor of the dual system.

Use of Electric Boilers Increasing

In passing, reference should be made to the impetus given recently to the use of electric boilers on this side of the Atlantic and the large capacity of some of the units now in operation. Although their economic use is limited to localities where water power is abundant and cheap and coal or oil the reverse, something over 250,000 kw. of electric steam boilers have been installed or are under construction in this country and Canada. The Laurentide boilers in Canada, each capable of absorbing 35,000 kw. and producing 100,000 lb. of steam per hour, are the largest in service. At Berlin, N. H., the installation of an electric steam boiler of 18,000 kw. capacity has been completed within the year. Steam at 135-lb. gage is generated by three-phase 60-cycle current at 22,000 volts. The plant is one of the first to employ so high a voltage.

When these experiments have been carried to fruition, the tangible results secured will serve to point the way. At the present in average practice pressures are gradually increasing and economies improving. Designs of boiler and all auxiliary equipment and appurtenances have been worked out and established for pressures up to 400 lb., and the stage is set for a new advance into the regions under exploration. These tendencies naturally impose more exacting conditions such as boilers free of scale and additional precautions to guard against the increased tendency to foam and prime as the steam becomes denser and the water lighter. In other words, better water is imperative, so that evaporators, purifiers and water softeners of various types, the choice depending upon the percentage of makeup, the character of the water and the investment warranted, are coming into more general use. The subjects of scale formation in boilers and concentration of boiler water are being given more intensive study.

In the physical proportions of boilers there has been no radical departure during the year. In the larger plants units of 14,000 to 20,000 sq.ft. have been installed in most cases. The Cleveland Electric Illu-

minating Co. boilers with 30,600 sq.ft. of surface hold the record for size, although boilers somewhat larger are in prospect. Some attention has been given to the one-turbine, one-boiler idea, with a view to simplifying plant and piping design and reducing boiler-room labor. It has been demonstrated that a boiler of 41,000 sq.ft. operating at 300 per cent rating could supply a 30,000-kw. turbine. Over the largest boiler in use in this country it would mean an increase of 40 per cent in the area of heating surface provided. The building of such a unit would be feasible and with station kilowatt capacities running into the hundred thousands, feed water freed of scale and air and automatic control more highly developed, such a unit would represent a relatively small part of the total capacity, it could remain in service as long as the turbine and its operation would be no more intricate than that of a smaller boiler.

In bent-tube boilers changes in baffling and in the relative number of tubes in the respective banks have resulted in greater economy. Drop-leg construction in horizontal water-tube boilers with no baffling in the lower deck is gaining in favor. With the lower gas velocities slag formation has been less and its removal facilitated. Superheaters located nearer the fire, either between tube decks or between the boiler tubes, are giving more uniform steam temperatures, as they are in position to absorb heat both by radiation and convection and are subject to the same fluctuations in gas temperature as the more active part of the heating surface.

Developments in Radiant Heat

Purely radiant superheaters are being improved, and from results obtained in studies of the variation of superheat with rating and the composition of the gas, it has been found desirable to perfect a combination convection-and-radiant-heat type of superheater. Passing the steam through the two superheaters in series insures almost constant steam temperatures over a wide range of conditions.

The advantage of exposing the steam-making surface to the radiant energy of the fire is reflected in all recent designs, and the tendency is to increase this surface to the maximum even to the extent of lining the furnace walls with tube surface, similar to the water screens of powdered-coal furnaces. Evidently, this arrangement would protect the brickwork and relieve to some extent one of the most troublesome problems of the day. Data are available to show that the absorption of radiant energy does not lower furnace temperatures as much as might be anticipated, and even if it did, the more ready absorption of radiant energy would overbalance the reduction in heat absorption by convection, so that higher boiler efficiency would result. As a means to this end, protection of the refractory furnace lining would permit higher furnace temperatures, the use of less excess air and make it possible to preheat the air entering the furnace, with no deleterious effects. With no brickwork at a white heat, ignition perhaps would be retarded, but this would be a detail open to solution varying with the kind of fuel burned.

The intensive study of furnace-operating problems has led to many suggestions. One of the most interesting is that the Gordian knot be cut by simply doing away with the refractories. This suggestion is receiving serious attention. In fact, at the Hell Gate Station an experimental boiler with water-tube walls is nearly ready for test. In this boiler the side walls are formed of water tubes with an outer layer of ordinary heat insulation. If such furnaces prove practicable, it should increase the desirability of the air preheaters, since the refractory problem would be solved and warmer air would be useful in counteracting the cooling effect of the water tubes.

Large Combustion Space Favored

In large power stations the tendency is steadily toward larger combustion space. Furnace volumes have increased from, say, 0.1 cu.ft. per square foot of heating surface in the older stations to a figure approaching 0.6 cu.ft. in the most recent stoker plants, and in one of the latest powdered-coal installations the volume is about 10 per cent greater than this. Such enlargement, by increasing the expanse and weight of wall exposed to furnace temperatures, adds to the initial investment and the cost of maintenance. Authorities in the field are beginning to question the extent to which this movement should be carried. It is a question of cost versus improved economy, and the problem is to discover the economic balance that will produce steam at the minimum cost.

With the higher steam and gas temperatures, the interest in economizers has been renewed. For medium pressures the cast-iron economizer still has a place, but the integral economizer, owing to corrosion difficulties and poor circulation and heat transfer, is giving place to the counterflow steel-tube unit installed for individual service. A continuous passage with rounded turns provides for smooth uniform water flow at minimum resistance, and the single pass for the gases in the opposing direction gives maximum heat transfer. Deaërating devices of various kinds, by removing the corrosive agency from the water, guard against internal corrosion, and in certain types cast-iron elements protect the external surface of the steel tubes. In a comparatively recent design the steel tubes are protected against both outside and inside corrosion by impregnation with a lead compound.

Stage Bleeding Makes for Economy

Stage bleeding from the main turbine to heat the feed water is gaining in favor, and the tendency is to subdivide the process into two, three or more steps. In fact, if it were not for the great expense involved, economy alone would dictate an infinite number of heaters ranged from the exhaust to the inlet of the turbine. For the same reason, economy, it is also proposed to preheat combustion air with extraction steam or by the waste gases from the boiler. This movement is cutting into the field of the economizer and, in advance practice with both extraction heating of feed water and air preheating with the waste gases of combustion, may eliminate it entirely. There are many questions involved, however, such as relative heat transfer, deterioration, temperatures permissible at the grate and in the furnace, so that for years to come there will be a place for both types of equipment and in some cases for both of them in the same plant. Although the air preheater is not new, recent investigation has shown that it has greater possibilities than had been anticipated. More about it will be known when data are available, from installations of the various types of preheater now being tried out.

All of this, however, has been discussed in the Dec. 4 and 11 issues of *Power* and more fully than space here

will permit. It will suffice to add that extraction heating has hastened the trend toward an all-motor drive for station auxiliaries from the main generator or an auxiliary machine on the same shaft, with perhaps synchronous motors and dual steam drives in reserve on some of the more important equipment. Satisfactory automatic control of these various motors, particularly those in the boiler room, has introduced a number of interesting problems.

Even with steam-driven pumps the control has not been perfect. With boiler feeders there has been difficulty in maintaining the constant differential desirable between water and steam pressures, for the efficient functioning of feed-water regulators. One of the accomplishments of the year was the perfection of an excess-pressure regulator designed to maintain a constant differential regardless of fluctuations in steam pressure with either steam- or motor-driven boiler-feed pumps. There have been improvements in small steam turbines for auxiliary drive, not only in construction and control, but in economy as well, and this same statement might also be applied to auxiliary equipment in general.

For combustion control a new electric system has been applied in two different plants. It consists essentially of a master control made up of a three-unit motor-generator set under the primary control of a steam-operated regulator. The set is made up of an adjustable-speed direct-current motor connected through flexible couplings to two generators, one for fan-motor field excitation and the other for stoker-motor field excitation. The generators have sufficient capacity to supply the sum of the field currents for each group of motors and are so calibrated that they will control the speed of the motors throughout their entire range and also maintain the correct ratio between fan-motor and stoker-motor speeds. The master regulating rheostat on the driving motor of the set, in accordance with the total load on the plant, operates to proportion the load equally between the boilers in service. The system includes, as well, motor-control of the dampers with gasometer regulation actuated by the furnace pressure.

To check and help maintain the higher economies from improved equipment, the instrument field has been active. A new steam-flow meter, correcting automatically for variations in steam pressure and temperature, has made its appearance, other meters for the measurement of steam have been improved and simplified, and new combinations, to give other data on the same chart, effected. Among the new developments may be mentioned a combination barometer and vacuum recorder, a hand tachometer fitted with speed-recording mechanism, three new electrical CO_2 meters making use of the variation in thermal conductivity of the flue gases, draft gages of the dial type readable across the boiler room, an instrument for indicating and recording variations in the water level in a boiler under pressure and a variety of other devices, all designed to give the operator some specific information and help him visualize the actual operating conditions.

Steam-Turbine Development Influenced by Higher Pressures and Reheating

ADVANCES in large steam-turbine practice, as cited in last year's review, were representative of new principles of construction. Changes in design of blading, leading to larger capacities, better efficiency and increased rigidity, standardized arrangements for bleeding, the use of higher pressures and temperatures, as well as improvements in emergency governing devices, were most prominent.

While new constructional principles are comparatively of minor importance, during the last year's developments the application of those principles previously introduced, has led to interesting forms of turbine units, representing the use of higher pressures than previously specified and suggesting the important part that especially designed prime movers will play in obtaining maximum efficiency in the future.

The cross-compound unit originally had been strongly sponsored in this country. However, this type, until lately, had made such comparatively little progress here that it appeared as if American practice was awaiting the wider adoption of this design in Europe. It seems, however, that the advantages of this type have been quite suddenly seized upon in many quarters. In one instance three units, including both reaction and impulse types of approximately 40,000 to 50,000 kw. capacity each, operating on the cross-compound principle, are on order for one plant. C. A. Parsons & Co. of England is supplying one unit. Requirements of reliability, space and efficiency, especially in connection with the reheating cycles, have been dominant factors.

The adoption of 1,200-lb. steam pressure has led to the design of an impulse high-pressure unit, operating on the cross-compound principle, so that the exhaust at 350-lb. pressure is reheated before being supplied to the remaining units of the station. Another striking application of the cross-compound principle is that of a direct-current generator geared to cross-compound impulse turbines capable of carrying a maximum load of 6,000 kw. This is being built by the DeLaval Steam Turbine Co. and represents a maximum of reliability inasmuch as one of the units may carry approximately three-quarters of full load in the event of the other being inoperative.

As the result of a study of the high-pressure turbine for 1,200-lb. steam, exhausting at 300-lb. gage, by the Westinghouse Electric & Manufacturing Co., the final designs now in progress include a special high-pressure water gland known as the boiler-feed pump type. Condensate from the main condenser is used as sealing water. This gland acts as a stage heater and retains in the system most of the heat that would otherwise be lost through friction and condensation in the gland. The heated water it returns to the boiler.

A 50,000-kw. reaction unit has been designed as a three-cylinder machine, the high-pressure and intermediate-pressure elements being connected in tandem to one generator. The low-pressure element is a double-flow unit driving a generator, which represents a separate element as cross-compound with the other two. This operates at 1,800 r.p.m.

A novel feature of this unit is the use of twin vertical surface condensers, one on each side of the turbine, with their upper water-boxes above the engine-room floor. The steam leaving the high-pressure turbine is conducted to the boiler room and reheated to 700 deg. F. before entering the intermediate-pressure element. Many special problems were introduced by reason of the high temperatures resulting from this arrangement. After careful study, the high-pressure and intermediate-pressure elements were separated so that they might expand freely. On account of the comparatively large volume in the reheater and its connected piping containing steam no longer under control of the regular turbine governor, special arrangements for governing are required to prevent overspeeding of the turbine in case of a sudden reduction in load.

As a result of applying close axial-flow clearances in the high-pressure blading of a 5,000-kw. reaction-type unit built by the Allis-Chalmers Co., actual tests disclosed relatively higher efficiency than obtained with radial clearances. A 20,000-kw. unit has been constructed with this provision for 400 lb. gage, 700 deg. F. steam.

The General Electric Co. has under construction one 2,600-kw. and one 4,000-kw. turbine designed for a steam pressure of 1,000 to 1,200 lb. and to exhaust into headers supplying other turbines at from 250 to 350 lb. These machines are an entirely new departure and involve special boiler equipment. The turbines, however, are simple in design and present no obstacles to the ultimate success of the system adopted.

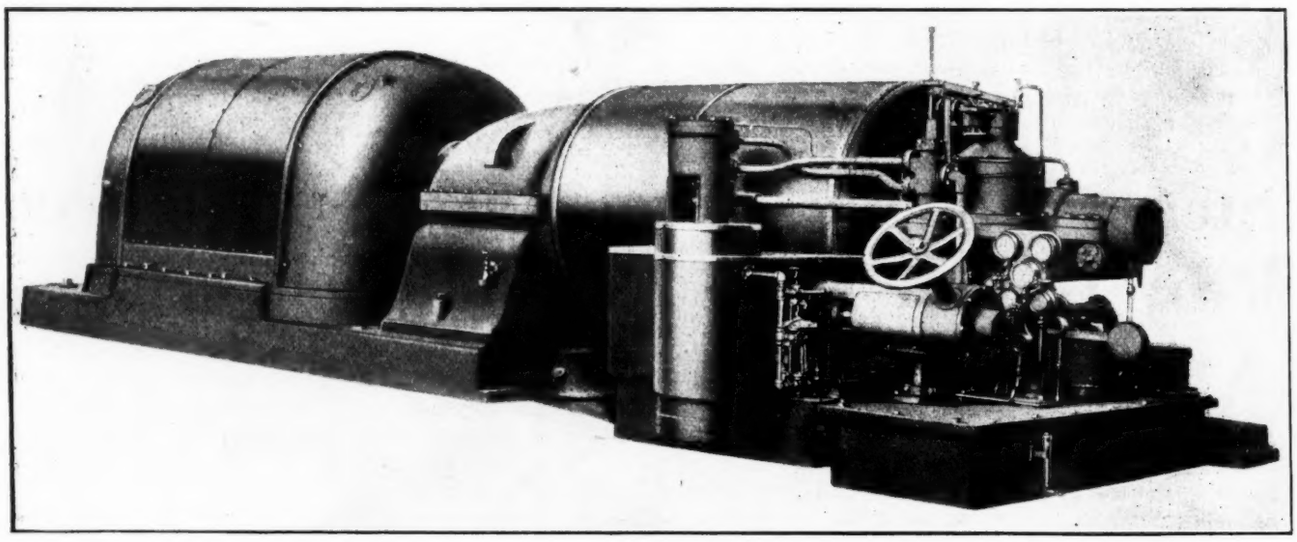


Fig. 1—Reaction turbine with close axial clearances in the high-pressure blades

The pursuit of higher efficiency has led to the consideration of a base-load type turbine. This has not up to the present time been the subject of exact determination in design and construction. It is to be operated as nearly as possible at the most economical load, and features of flexibility in handling different loads as well as other factors, may be sacrificed in order to obtain the highest possible operating efficiency.

House Turbines

The study of the problem of bleeding the main unit for heating condensate has brought out that the house turbine, being a smaller unit, is inherently less efficient for heating feed water than the main unit. This condition holds when current for the auxiliaries is not subject to transformation by motor-generator sets or other apparatus involving losses chargeable to the main units, but which are not similarly attached to current derived from the house turbine. This has led to the adoption of the auxiliary generator placed on the shaft of the main unit for the purpose of furnishing a separate source of current for the auxiliaries. Where such current must be transformed from the main unit and a considerable loss in efficiency occurs thereby it is possible under such circumstances to provide a house turbine that may furnish auxiliary current at a greater operating thermal efficiency, if not subjected to such losses during transformation, than that of bleeding the main unit where large transformation losses are involved.

Small Steam Turbines

Several new lines of auxiliary turbines have appeared during the last year. There has been a general development toward making them suitable for higher pressures and temperatures. Steel casings have been substituted for cast iron. These casings are sometimes supported close to the center line so that expansion will have comparatively less effect in changing alignments from cold to hot temperatures. An auxiliary turbine, built by the Allis-Chalmers Co., contains a hand adjustment for speed regulation. The governor contains no pivots or knife-edge links, as the flyball weights are given a rolling motion against a flat guide surface. This machine also utilizes air for cooling the oil.

Bleeder turbines have been in demand for manufacturing processes. The mixed-pressure turbine applications offer an important field. An interesting development is a turbine generator unit, which may function condensing either as a high-pressure unit, a low-pressure, mixed-pressure or an extraction type unit, and, non-condensing, as a high-pressure unit depending on the steam and load conditions which it must meet. This is manufactured by the DeLaval Steam Turbine Co.

A novel development of non-condensing turbines is a back-pressure control valve, which is designed to govern the power output of the unit in a direct proportion

to the amount of steam that must be exhausted at a certain predetermined pressure. In other words, steam is admitted to the turbine so that the exhaust pressure will be maintained practically constant. The valve is controlled jointly by the centrifugal governor and a pressure regulator operating from the exhaust. The alternating-current generator floats on the line and delivers an amount of load in direct proportion to the demand of exhaust steam from the non-condensing turbine. This is a hydraulic type of valve designed by the Moore Steam Turbine Corporation, controlled by both a pressure regulator and a centrifugal governor.

Condenser Development

Little development, comparatively, has been noted in the design of condensers themselves. Auxiliaries, however, have been subjected to innovations to some extent, as mentioned in another part of this review. Condenser practice has brought out the fact that tube corrosion in some instances is caused by pockets formed by water turning short corners as in entering condenser tubes. A special entrance nozzle has been placed on the market, by the Albert E. Mace Co., for the purpose of securing a flow into the tube which will be free from *vena contracta*. Two 70,000-sq.ft. single-shell surface condensers have been built by the Westinghouse Electric & Manufacturing Co., which are believed to be the largest made up to the present time. Hotwells for surface condensers have been developed wherein the excess oxygen contained in the condensate is reduced to practical elimination.

Valves Suitable for High Temperatures and Pressures

A year ago the sentiment was to some extent prevalent that the adoption of higher pressures and temperatures depended on the ability of the manufacturers to produce suitable valves. Now it is quite evident that valves for high pressures and temperatures may be had in a number of designs. One previous development which now receives much attention is the use of remote control, electrically operated valves; another is the use of steel, which has been cast and normalized, according to the latest methods of heat treatment.

High temperatures and pressures, such as 800 deg. F. and 400 lb., are at present in use in the oil-refining industry. As a result of these conditions a forged valves in sizes up to 4-in. has been developed by the Henry Vogt Machine Co. This is equally suitable to steam service. It is possible that forged-steel gate valves in larger sizes may soon be on a basis competitive with cast-steel valves. A vertical non-return valve has been developed for connection between the boiler and header, by the Edward Valve & Manufacturing Co.

In connection with valves and fittings it should be mentioned that tentative standards for pressures up to 900 lb. per sq.in. and at a temperature of 750 deg. F. have been adopted recently. Manufacturers are therefore at liberty to design valve flanges with reasonable assurance that they will match other fittings.

Extreme pressures and temperatures have brought out that special material, designs and heat treatment are necessary. Standard valves, under such conditions, must conform to rigid specifications involving chemical analysis, normalizing, by the application of heat, tests of physical properties, etc.

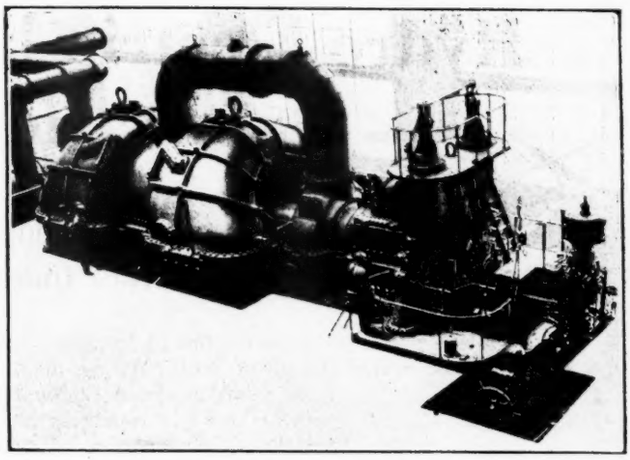


Fig. 2 — Tandem-compound 50,000-kw. Westinghouse turbine on test

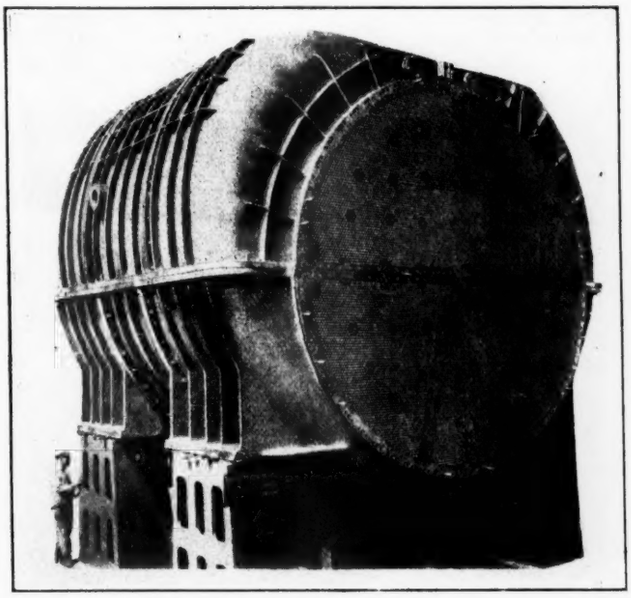


Fig. 3 — Single-shell 70,000-sq.ft. surface condenser believed to be the largest built

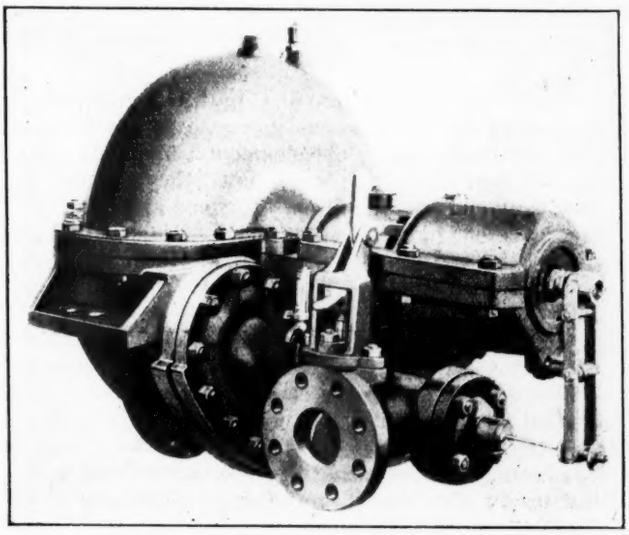


Fig. 4—Central support of casing in an Allis-Chalmers auxiliary-drive turbine

Hydro-Electric Development Shows Unprecedented Activity

Over Two Million Horsepower of New Hydro-Electric Plants and Extensions to Old Installations, in Projects of 10,000 Hp. and Larger, Were Completed During 1923 or are Now Under Construction in This Country

ALTHOUGH water-power development has continued to be the storm center of political and private interests, it has kept forging ahead under the tremendous demands for power and can report greater activity during 1923 than for any previous twelve months. The Federal Water Power Commission has been the center of much of this controversy, some states going so far as to bring suit against the commission to test its jurisdiction over water power on navigable streams. There seems to exist at this time a great divergence of opinion among the governments of some states as to what their policy toward water-power development should be, some going so far as to suggest that all water-power development should be stopped within their respective states until they can determine how it should be carried on. In some states legislation has been enacted to prevent the transmission of power out of the state, while in others inhibitions are being considered against allowing power to be transmitted into the state.

Of the outstanding projects, the Colorado, Columbia, St. Lawrence and Muscle Shoals, representing some 13,000,000 hp., that were reported in last year's review as tied up in a political tangle, not much progress can be reported at this time. On the Colorado development has been prevented owing to Arizona's refusal to ratify the treaty that was negotiated by Secretary Herbert Hoover among the seven states interested in this project.

Outside of the sale of the Gorgas steam plant and that the government is continuing work on the Wilson dam and the power house, what is to be done with Muscle Shoals is still open to conjecture. President Coolidge, in his message to Congress recommended that this property, with a location for a steam plant and rights of way, be sold and that Congress appoint a small joint committee to consider offers, conduct negotiations and report definite recommendations.

Development on the Columbia is held up awaiting the findings of the investigation of the Columbia basin authorized by Congress. One of the chief subjects of the controversy over the use of this river is the reclamation and power interests. Considerable interest has been centered on the Priest Rapids development, which involves 750,000 hp. An application has been made to the Federal Water Power Commission for a license to develop this site, and those making the application have agreed to begin construction work just as soon as the license is granted. This site is about halfway between Spokane and Portland and will require a dam 2½ miles long to control a maximum river flow of over 700,000 cu.ft.-sec.

Developments on the St. Lawrence are awaiting an agreement between this country and Canada before anything can be done on this project, and the last year apparently has not produced anything that looks very promising for an early settlement of this question, although the country has recently made representation to Canada in regard to negotiating an agreement. In fact, interests in New England that one year ago were

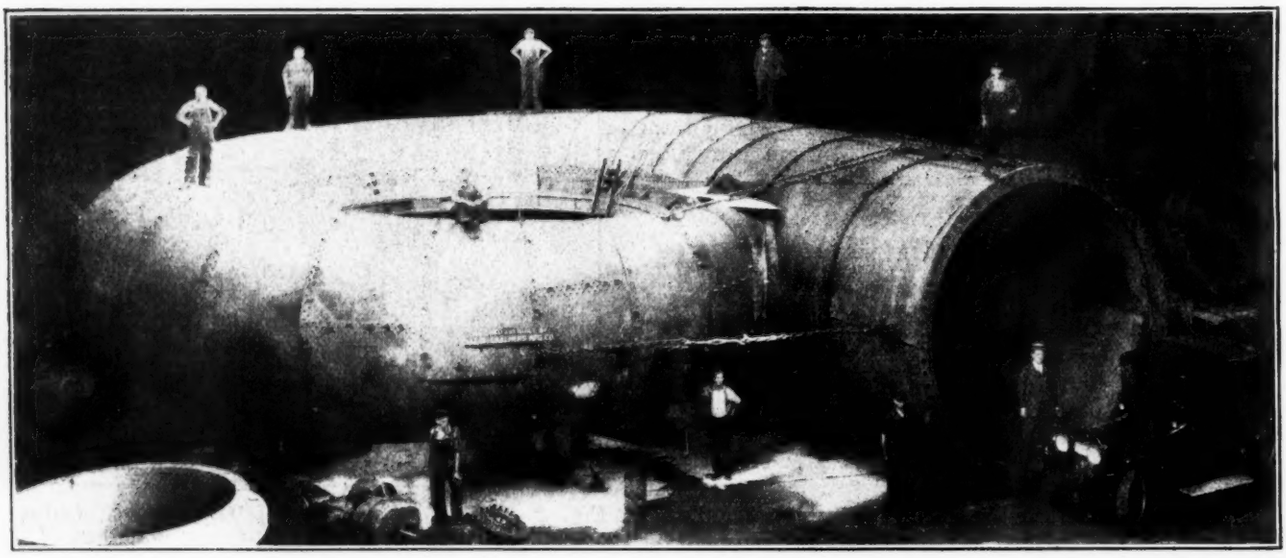
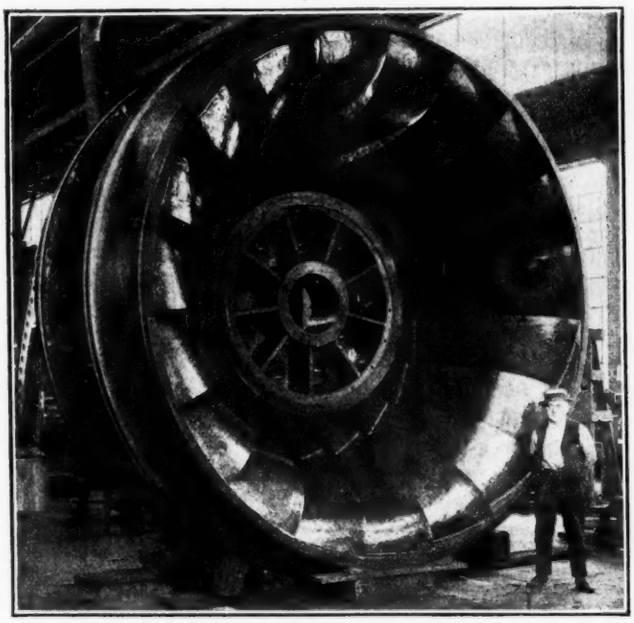


Plate-steel spiral casing for the 70,000-hp. Allis-Chalmers turbine being installed in the Niagara Falls Power Company's plant

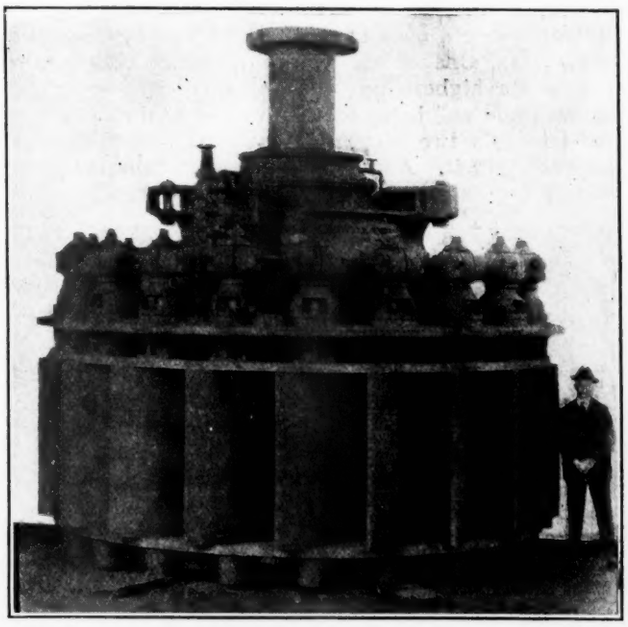
considering the possibilities of obtaining power from the St. Lawrence, see this project tied up indefinitely and are turning their attention to supplying their power needs from the hydro-electric developments in the Province of Quebec or elsewhere. Thus another twelve months has passed without anything definite being done to turn these great power resources toward contributing to the nation's welfare. In spite of this, however, water-power development continues to maintain a healthy outlook in those locations where there is less clashing of interests.

The foregoing statement is verified by the report of the Federal Water Power Commission, which has been issued for the fiscal year ended June 30. This report states that "applications involving an estimated installation of 21,500,000 hp., permits and licenses issued for an aggregate installation of 7,500,000 hp. and 2,400,000 hp. built or building under license of the commission is the record of three years' administration of the Federal Water Power Act. In this period the commission has dealt with applications involving six times as much horsepower and has twice as much horsepower built or building, as the individual departments working independently in the preceding twenty years. When it is realized that only 1,400,000 hp. had been constructed under Federal authority in the years preceding the passage of the act and that at the time of its passage the aggregate installation in all water-power plants in the United States amounted to only 9,000,000 hp., the satisfactory character of the legislation and the substantial results accomplished in its administration are apparent." Among the permits issued dur-



Runner for one of two 70,000-hp. I. P. Morris turbines being installed by the Niagara Falls Power Company

ing the last year by the commission is that to the Susquehanna Power Co., which involves a development of 360,000 hp. on the Susquehanna River. Another permit that involves large power possibilities is that to the West Virginia Power & Transmission Co. on the Cheat River, where an installed capacity of 600,000 hp. is considered possible. During the fiscal year ended June 30, the commission had issued permits involving an installed capacity of approximately 3,000,000 hp. Licenses were issued during this same period for the installation of 635,000 hp. Although this figure is less than for the two preceding years, it probably represents a larger amount of new work, since in 1921 and 1922 licenses were granted to a number of companies that



Assembled gate mechanism for 22,700-hp. S. Morgan Smith turbine to operate under 83-ft. head

had large capacities already installed but were operating under temporary permits.

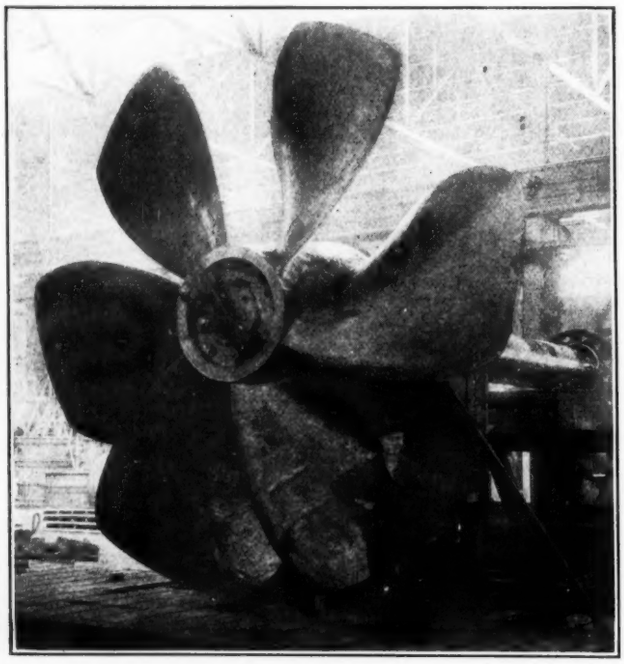
Contracts for hydraulic turbines let in this country and Canada approximated 2,000,000 hp. One company reports contracts for over 500,000 hp. covering 61 units in 31 plants, where another company reports over 380,000 hp. Reports indicate new business of nearly 1,000,000 hp. for hydraulic turbines being let in Canada alone. Of this 750,000 hp. was for the provinces of Ontario and Quebec. The largest contract was that for eight 40,000-hp. units, which went to an American firm. There were completed during the year or are now under construction in this country over 2,000,000 hp. of new hydro-electric plants and extensions to old installations. Allowing $150 per hp. installed, this represents an investment of $300,000,000. The ultimate capacity of these adds another 1,500,000 hp. These installations for the most part are for projects of 10,000 hp. and larger. There is undoubtedly considerable more business represented in installations of less than 10,000 horsepower.

Largest Project Started

From point of size the largest project started during the year was that of the Quebec Development Co. at Lake St. John on the Saguinay River, Quebec, Canada. This involved 1,200,000 hp., and the first development, when completed, will be 500,000 hp. Contracts for 320,000 hp. of machinery have already been let. Another important project under way, for which contracts for machinery have been let, is the La Gabelle development of the Shawinigan Water & Power Co. on the

St. Maurice River in Quebec. This development will have an initial installation of four 30,000-hp. propeller-type turbines to operate under a 60-ft. head. These are the largest units of this type that have been constructed and operate under the highest head for machines of their type.

The Oak Grove plant in Oregon, of the Portland Railway, Light & Power Co., will have installed in it ultimately three 35,000-hp. Francis-type turbines to operate under a head of 850 ft. and run at a speed of 514 r.p.m. One of the wheels is under construction and is the highest-head unit of this type so far attempted and will be fitted with rubber seal rings. Previous to this two 25,000-hp. turbines held the record for head, 810 ft. Another important installation under



Runner for one of two 28,000-hp. Dominion Engineering Works' turbines installed by the Manitoba Power Company

way on the Pacific Coast consists of three 33,000-hp. vertical Francis turbines to be installed in Pitt River No. 3 of the Pacific Gas & Electric Co. These units will also be fitted with rubber seal rings and will operate under an effective head of 280 feet.

Of plants completed or nearing completion, that of the Niagara Falls Power Co. and the Queenston plant of the Ontario Hydro-Electric Power Commission have the largest-capacity units. The first 70,000-hp. turbine in the extension to No. 3 plant of the former went into service Dec. 18, and the other two will be ready for operation in the early part of 1924. These turbines are the largest capacity that have ever been constructed and will operate under a head of 214 ft. and run at 107 r.p.m. A Johnson valve is installed on each machine at the lower end of the penstock and a butterfly valve at the upper end. During the last twelve months, units 5 and 6 have been installed and put into operation in the Queenston plant and the foundation has been completed for units 7 and 8. These two machines were ordered the early part of the year and will be in operation by the middle of 1924. The station will then have a capacity of about 500,000 hp., or 8 units of 60,000 hp. each.

The official test was made during the last year on No. 5 unit in the Queenston plant and gave notable results. The maximum efficiency developed was 93.3 per cent, and the average efficiency developed throughout the operating range is believed to be the highest ever attained. An efficiency of over 90 per cent was obtained for a load range of 30,500 to 63,200 hp. These efficiencies are a good indication of the development of the mixed-flow turbines.

The Sherman Island plant, on the Hudson River, of the International Paper Co. went into operation with an initial capacity of four 10,000-hp. units under a 66-ft. head. There is space for one more unit in the station. One of the interesting features of this project is that the dam, canal headworks and plant are built on fine sand in some places underlaid with quicksand. Another plant that was built on quicksand is the Alcona station of the Consumers Power Co. in Michigan. The plant is of 11,000-hp. capacity and is equipped with a Tefft conduit spillway through which the flood water is discharged into the bottom of the draft tubes, thus increasing the head on the plant.

Two 20,000 units have been added to the Holtwood plant of the Pennsylvania Water & Power Co. These are equipped with single Francis-type runners to operate under a 62-ft. head and occupy the space originally intended for a vertical-type double-runner 13,500-hp. unit. These machines are set over a Moody spreading-type draft tube. The discharge portion of the water passage is a spiral similar to the scroll case of the turbine. The draft tube is designed for minimum space requirements and is believed to be the first application of a spiral draft tube to a large installation.

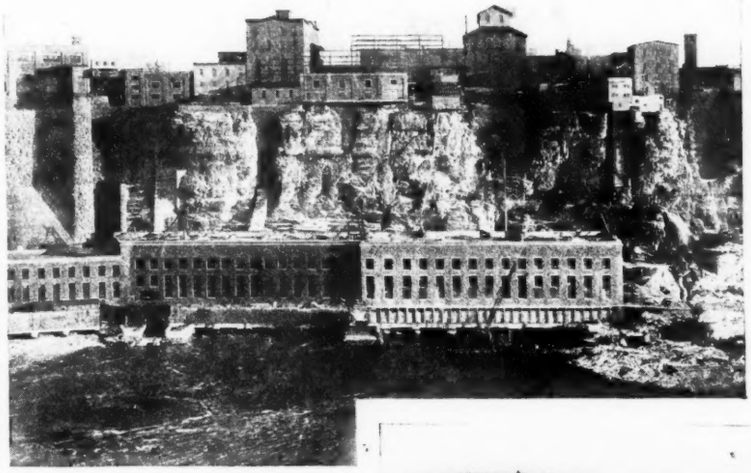
Developments in the Southeastern States

The Mountain Island plant of the Southern Power Co. was completed during the year, with four 22,700-hp. units to operate under a head of 83 ft. The Dearborn plant of this company was also completed with three units of 17,000 hp. for a head of 72 ft. The Tugaloo Development of the Georgia Railway & Power Co. will have four 22,700-hp. units operating under a 149-ft. head, two of which have gone into service. From point of interest one of the most important plants to go into operation during the year was the Mitchell dam plant of the Alabama Power Co., which in the initial installation has three 24,000-hp. units to operate under a 70-ft. head. Each unit is housed in a separate compartment built on the upstream side of the dam. This construction was necessary so that the Thurlow backwater suppressor could be embodied in the design of the dam. In this design the flood water is allowed to flow over the dam in such a way as to prevent a reduction of head due to increase in height of the tailwater.

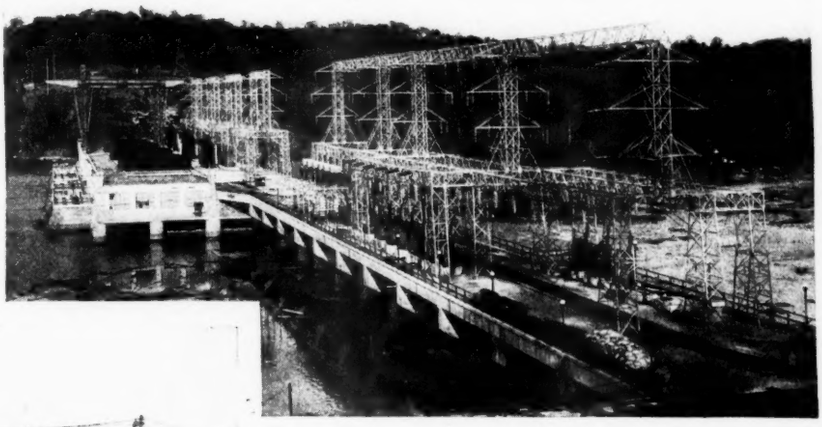
On the Pacific Coast Big Creek No. 3 of the Southern California Edison Co. is among the most important. This plant is on the San Joaquin River, and the initial installation consists of three 35,000-hp. vertical Francis-type turbines operating under a head of 760 ft. at a speed of 423 r.p.m. The Gorge plant of the City of Seattle (Skagit River development) is nearing completion, in which there are being installed two vertical-shaft Francis-type units of 40,000-hp. capacity each, to operate under a 375-ft. head of 257 r.p.m. These

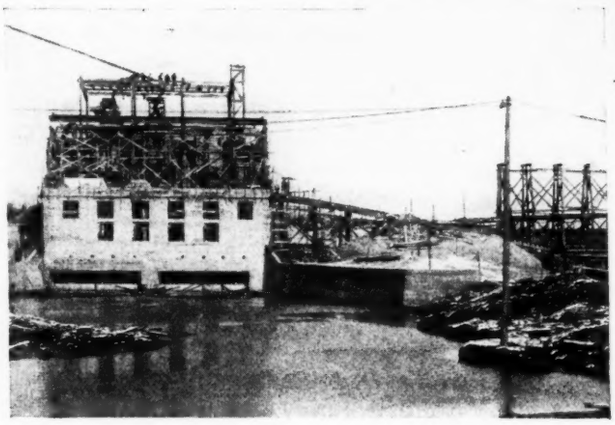
Hydro-Electric Plants Nearing Completion

Left — Plant of Niagara Falls Power Co. New section at the right is known as Station 3-C and will contain three units rated at 70,000 hp. each, one of which is in operation. The middle section, 3-B, contains three 37,500-hp. units, and the lefthand section has thirteen 10,000-hp. machines in operation.



Right—Mitchell Dam development of the Alabama Power Co. on the Coosa River. Each unit is housed in a compartment built on the upstream side of the dam. Three 24,000-hp. machines are now installed.





Left—Alcona plant of the Consumers Power Co. on the Au Sable River, Michigan. This plant is built on quicksand and will house two 8,000-hp. units to operate under a 41-ft. head.

Below—Sherman Island plant of the International Paper Co. on the Hudson River. This plant is laid out for five 10,000-hp. units to operate under a 65-ft. head; four are installed and went into operation the latter part of the year.

units have cast-steel spiral cases, with direct-connected synchronous pressure regulators. The head will temporarily be 275 ft. effective.

A unit designed to meet special head conditions is one for the Salt River Valley Water Users' Association, of 10,000 hp. maximum rating, covering a head range of 100 to 230 ft. This unit has special gate stroke limiting mechanism for this unusual head range. A notable variable-head installation is that for the Turlock and Modesto Irrigation Districts. Three units are of 12,000-hp. maximum rating each, and operate over a range of heads from 100 to 240 ft. A constant speed of 300 r.p.m. is maintained over the range.

High-Head Wheels Installed

There has also been installed a number of impulse wheels for high heads on the Pacific coast during the last year. Among these might be mentioned four 25,000-hp. units in the Moccasin Creek plant (part of the Hetch Hetchy development) of the City of San Francisco for a head of 1,200 ft.; an additional 30,000-hp. unit in the Caribou plant of the Great Western Power Co. for operation under a 1,000-ft. head; one 22,500-hp. unit for a 1,900-ft. head by the Southern California Edison Co., and two 14,000-hp. units for a 1,750-ft. head by the Western States Gas & Electric Co. Although the foregoing installations do not include all the important projects they do show what is going on in water-power development in this country and Canada.

There has been a number of installations made using the propeller-type runners, and equipment for a number of others is on order with at least three waterwheel manufacturing companies. The most important installation is that in the Great Falls plant of the Manitoba Power Co., where two 28,000-hp. units of this type have been in operation for nearly a year. These units are designed to operate under a head of 56 ft. but until the rock-fill section of the dam is completed, have been running under a head of about 22 ft. successfully.

One of the most interesting developments in the propeller-type runner is that reported from Sweden. This runner is 19 ft. in diameter, is designed for 11,500 hp. under a 21.25-ft. head. The blades are adjustable to accommodate the changes in load. This feature results in improving the part-gate efficiencies.

Another installation of particular interest is that comprising two 12,000-hp. turbines for the Hollinger Consolidated Gold Mines, Ltd., Ontario, Canada. A feature of these turbines is the ejector-type draft tube furnished to maintain the output at normal during the flood season when the effective head is reduced from 60 to 50 ft. This ejector mechanism consists of a cylindrical gate around the draft tube just below the runner, which is raised during the flood period to allow a portion of the excess water to enter the draft tube below the runner. This water is so directed as to give an ejector effect, thereby reducing the pressure below the runner and increasing the output of the turbine.

One turbine manufacturing company reports the development of a line of low-head high-specific-speed mixed-flow runners, an example of which is a 4,200-hp. unit to operate under a head of 35 ft. at 133 r.p.m. Another type of wheel reported during the year was a cross-flow impulse type, which is designed for a range of specific speed between 5 and 20, or that range, to which the present reaction and impulse types are not well suited.

The use of rubber seal rings has been greatly extended. The manufacturers report that during the year a number of installations have been made of turbines fitted with rubber seal rings and that development is progressing satisfactorily. The rings are now operating under 810 ft. head and 35,000 hp. turbine capacity. The first rings have been in successful operation continuously for about 14 months. Real progress is being made in their use, and there is every indication that they will solve a problem that has been of great concern to turbine builders.

Another feature that has been given particular attention is the design of draft tubes. Extensive tests have been carried out, which have resulted in a better understanding of the whole problem. Efficient designs that were difficult to construct have had features incorporated in them which have greatly simplified their construction without decreasing their efficiency.

Use of Automatic Stations Increasing

Automatic and remotely controlled hydro-electric stations are rapidly increasing in number. The economic size of such stations apparently has not been reached. The most important plant of this type to go into service last year was the Searsburg station of the New England Power Co. This plant consists of a 7,500-hp. Francis turbine directly connected to a 5,000-kva. generator, and can come on the line in 35 sec. from a dead standstill. There is being installed by the Adirondack Power & Light Corp. a 1,500-kva. unit which will be automatically controlled. Another plant that will have full automatic and supervisory control is one in which there will be installed two 4,000-kva waterwheel generators.

Measuring of water to hydro-electric plants is receiving more attention than ever before. How this shall be done is still an open question. There are two methods, the Gibson pressure-time and the Allen salt-velocity, that are considered favorably by both the turbine manufacturers and operators, as a means of obtaining the instantaneous flow in closed penstocks for test purposes. In some of the high-head plants in the West, venturi tubes are being installed in the penstocks, and in other plants the pressure differential across a valve or section of penstock is being tried as a means of obtaining a continuous record of the flow to waterwheels.

From every part of the country come favorable reports for hydraulic-turbine business. The statement of one manufacturer follows:

> Great improvements in present-day waterwheel and turbine construction have made possible the increase of both power output and operating efficiency to be secured from old plants by the installation of new working parts. We find a strong tendency on the part of users of old equipment to modernize their installations, and a great deal of constructive work is being accomplished along these lines. The outlook is good, and we are so confident of continued hydro-electric development that we are doubling the capacity of our works by the addition of new buildings and tool equipment.
>
> Full automatic plants of small size have been installed during the year by several of the power companies, and among the larger public-utility companies the process of converting plants of considerable size into automatic operation is going on apace. The economic development of water power is being assisted considerably by the proved success of the automatic control, both for impulse wheels and turbines, and the power companies have been quick to take advantage of this.

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Electrical Power-Equipment Development

Volume of Business Larger Than Ever Before—Units of Unusual Size Constructed and Put Into Service—Increasing Use of Full Automatic Control for Hydro-Electric Units, Substation Equipment and Industrial Synchronous Motors

THE year 1923 has been one of greater activity in the electrical industry than any preceding, exceeding in many cases the maximum war-time production. Although in point of new developments the last twelve months may not have come up to previous years, in volume of business the figures surpass anything heretofore attained. Construction work under way during the year amounts to over 5,000,000 kw. of generating equipment in sizes of 10,000 kw. and above. Power generated by the central stations in this country reached over 44,000,000,000 kw.-hr., an increase of about 16 per cent over the previous twelve months.

One manufacturing company reports that during 1922 it placed in service 32 steam-turbine generating units varying in size from 3,750 to 43,750 kva., totaling 427,150 kva. For the first ten months of 1923 contracts were received and the company now has in process of construction and installation 82 steam-turbine generating units of 3,750 kva. and larger, totaling 1,644,235 kva. The number of large units that will be placed in service in 1923 and 1924 will exceed all previous records of this company. Another company reports shipping 1,660,000 kw. of turbo-generators. This is an increase of 85 per cent over the average for the preceding five years and an increase of 32 per cent over 1917, which was the maximum war-time production.

Important Projects Completed

Last year saw the completion of a number of important projects that had been under construction since 1921 and 1922. Among these were two 220,000-volt transmission lines which went into service on the Pacific Coast. This is the highest transmission voltage used in the world. The first of these was that of the Southern California Edison Co., which went into operation in May. In this case the voltage was raised on the two Big Creek lines, from 150,000 to 220,000 volts. On Nov. 16 the Pacific Gas & Electric Co. put into service one of its Pitt River circuits at 220,000 volts. Thus another milestone in high-voltage electrical transmission of energy has been established.

As reported in the sections on power stations and hydro-electric developments, many large generating units have gone into service. Large units continue to be in favor on systems where they can be economically used. Two 62,500-kva. steam-turbine-driven generators are under construction and will be ready to go into service in 1924. One of the three 65,000-kva. water-wheel generators that have been under construction during the past twelve months went into operation Dec. 18, and the other two will be ready for service before the end of 1924. A 43,750-kva. 1,800-r.p.m. turbo-generator is under construction, which is the largest machine of this speed ever built. There is also under construction a 62,500-kva. cross-compound unit consisting of a 25,000-kva. and a 37,500-kva. generator. Another 62,500-kva. cross-compound machine consists of two 31,250-kva. units.

A new development during the year was the supply of power to electrically driven auxiliaries from an auxiliary generator directly connected to the main unit. This constitutes an independent source of power for the auxiliaries and replaces the house-turbine generating set.

The closed system of supplying cooling air to alternating-current generators made tremendous advances during the last twelve months. A method that is meeting with wide application is one where the air is cooled by passing over radiators consisting of finned tubes through which the condensate is pumped on its way to the feed-water heater and absorbs part of the generator losses. One company reports orders received for air coolers during the year for closed cooling systems to be installed on about 600,000-kw. of generator capacity.

High-Speed Water-Wheel Generators

On account of designing large reaction hydraulic turbines to operate under high heads, the speed of the machines has attained high values for this class of equipment. The generators must be designed for these speeds, and the last year records a 30,000-kva. and three 28,000-kva. units designed for 514 r.p.m. At the guaranteed 85 per cent overspeed the rotor's peripheral speed of the latter is five miles per minute.

An unusual thrust-bearing construction was provided for two 8,200-kva. 150-r.p.m. and two 15,200-kva. 120-r.p.m. hydro-electric units. In these the upper bearing structure, which is generally used to support the thrust bearing, has been omitted and the thrust bearing supported in the lower bearing structure, which was strengthened to carry the additional load. This arrangement permits ready access to the stator and rotor coils for inspection or replacement.

Two notable frequency-changer sets were put into operation during the year, one of 35,000- and the other of 37,000-kva. capacity. The former has a rating of 35,000-kw. generator output at 100 per cent power factor and is driven by a 47,800-hp. motor, which receives its power at 13,800 volts three-phase 60-cycles. The other set consists of a 37,000-kva. wound-rotor induction motor having a 60-cycle stator and a 25-cycle rotor; a 25,000-kva. synchronous generator; a 115-kw. exciter; a 1,600-hp. 25-cycle induction starting motor; and a three-phase 17,100-kva. air-blast transformer connected between the slip rings of the induction motor and the high-voltage 25-cycle busbars. This set is so designed that it acts as a voltage tie as well as a power and frequency tie between a 25- and a 60-cycle system, similar to that obtained through a transformer. One

company reports orders for eight frequency-changer sets ranging in size from 5,000 to 15,000 kva.

The increased use of synchronous motors and condensers shows a growing interest in power-factor correction and voltage regulation of alternating-current systems. One manufacturing company reports recent installations or under construction 24 synchronous condensers, ranging in size from 5,000 to 30,000 kva., having an aggregate capacity of 250,000 kva. Another company reports the sales of synchronous motors during the year aggregating 50,000 hp. The largest motors of this type reported for industrial purposes were two 3,350-hp. machines for direct connection to magazine-type pulp grinders. Other synchronous motors of particular note built during the year are three of 650 hp. each, to operate at 3,600 r.p.m., and a 1,700-hp. unit to run at 1,500 r.p.m. Another feature of synchronous-motor applications is the development of a line ranging in size from 20 to 100 hp. for direct connection to small compressors and other slow-speed loads. In last year's review there was reported the development of a high-torque synchronous motor, so-called super-synchronous motor. Two of these, rated at 500 hp. each, are being built for driving rolling mills.

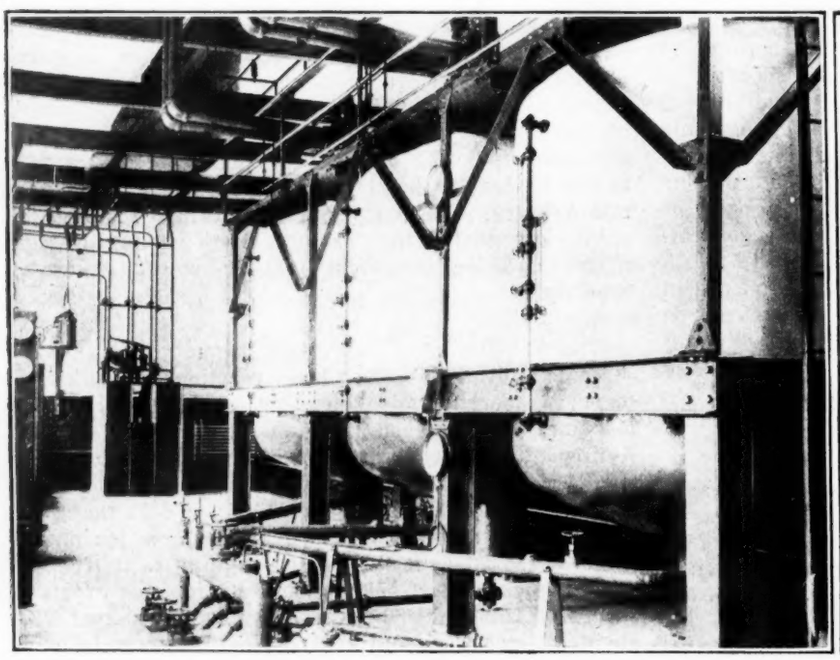
Another interesting installation of synchronous motors is that of two 250-hp. 600-r.p.m. 2,200-volt 60-cycle motors directly connected to rubber rolls without the usual clutch. These motors are equipped with full automatic starters using dynamic braking. On full voltage the motors will develop about 250 per cent full-load torque and a pull-in of about 100 per cent full-load torque. By dynamic braking the motors make only a little over two revolutions in dropping from 600 r.p.m. to zero speed.

Automatic starters are rapidly coming into favor for synchronous motors. One manufacturer reports that automatic starters were furnished with more than 50 per cent of its synchronous motors sold last year, and the percentage is constantly growing.

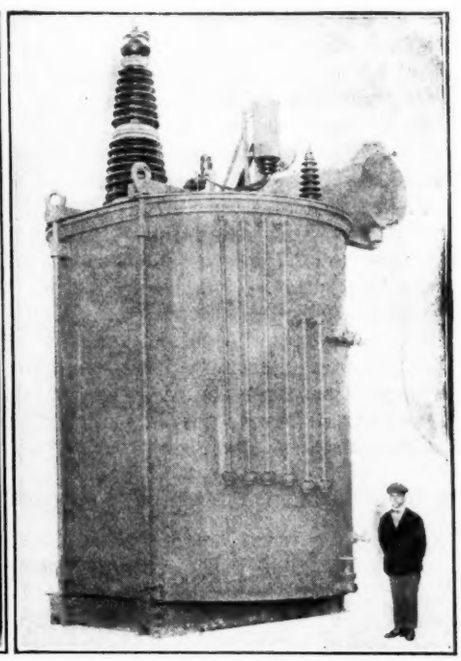
A number of new designs of industrial motors were developed during the year. One was an induction-synchronous motor. In starting, it acts as a wound-rotor induction motor, when it reaches near synchronous speed, direct-current excitation is applied to the stator winding and the motor pulls into synchronism. This motor can be designed to operate at practically unity power factor.

A single-phase motor was developed which operates on the squirrel-cage induction principle, but eliminates the short-circuiting switch. Both the maximum and accelerating torques are approximately 200 per cent of full-load torque. At no-load the speed is about 3 per cent above synchronous and at full load about 3 per cent below.

A brush-shifting polyphase motor having speed characteristics of a shunt direct-current motor was developed in sizes up to 75 hp. for operation on 550-volt circuits and below. This motor has two sets of brushes on a commutator, and speed adjustment is obtained by moving the two sets of brushes toward or away from each other.



Electric-Furnace Construction Co.'s electric-steam boiler of 18,000 kw. capacity for operation on 22,000 volts



General Electric 20,000 kva. 220,000 volt transformer

Automatic control of hydro-electric plant and substation equipment has continued to make substantial gains in numbers and capacities. It is now in operation or being installed in practically every state in this country, and important installations are being made in foreign countries. As already reported in the hydro-electric section, a 7,500-kva. unit in one plant and two 4,000-kva. units in another plant are being installed that will have full-automatic control.

For substation service there is under construction the largest single automatically controlled converting unit built to date. It consists of a three-machine motor-generator set rated at 3,750 kw. There are now

in operation two 1,800-kw. motor generators that are automatically controlled. Equipment for a 4,000-kw. 1,500-volt automatic substation is being constructed in this country for Japan. This consists of two 2,000-kw. synchronous converters and transformers. In this country automatic substations for mine and industrial plants have been installed in great numbers. A full-automatic station was applied to supply power to a multi-voltage system of elevator control in a large office building. This station contains three sets of four machines each, designed to supply 25, 50, 75 and 100 per cent voltage to the elevator system. In case of fault developing in one set of machines, another set is cut in automatically and the one in trouble cut out.

The tendency to concentrate large power capacity in transformer units continues. One company reports that the average size of the transformers constructed during the year was, self-cooled, 2,360; water-cooled 5,125; all types 3,220 kva. At the close of the year this same company had completed or had under construction a total of more than 180 units of 10,000 kva. or above. A bank of self-cooled transformers were delivered during the year which have a guaranteed continuous output of 56,000 kva. at 118,000 volts. Tests indicate that they would carry 60,000 kva. within their guarantees. They are probably the largest transformers ever built without recourse to artificial cooling. The construction of ten 22,000-kva. single-phase 25-cycle water cooled units for 12,000 to 68,000 volts for one company and eighteen 15,000-kva. oil-filled self-cooled units for 13,000- to 76,000-volt 60-cycle service for another company show the tendency in the sizes of such equipment. A single order was received in this country from Japan, for use it the rebuilt city of Tokio, for fifty-five 2,000-kva. and five thousand 15-kva. transformers.

A new development during the year was a unit in which an inert gas is introduced above the oil to prevent oxidization of the oil and also to eliminate the fire hazards in case of an explosion within the tank.

The most notable of the electric steam boilers to go into operation during the year was an 18,000-kw. unit for operation on 22,000-volt three-phase 60-cycle current. Steam is produced at 135 lb. gage, and the unit has a capacity of 50,000 lb. per hour. The boiler is installed for operation in a large paper and pulp mill on Sundays and holidays when the plant is shut down with the exception of the digesters. It operates on the surplus water power and results in a saving of about 70 tons of coal during each of these periods, which are of 23 hours' duration. The cost of the installation was $25,000, and the coal saved paid the cost in 46 days of 23 hours' operation.

Installation of this class of equipment is increasing quite rapidly, especially in sections where there is excess of water power. This is particularly true around Winnipeg, Canada, where about 50 installations of various size have been put in during the year. Some of these are being used as central plants to heat a number of large buildings in the business district, and some of them are going into laundries and other establishments.

Developments in the Oil-Engine Industry

THE year just passed has been remarkable for the number of new oil-engine designs brought out as well as for the number of firms extending the capacity and type range of their product.

The solid-injection engine is in many respects a distinct American development, European firms giving it little consideration until it had been well developed in this country. It is now generally acknowledged to possess certain merits as a prime mover of moderate capacity. As a result of the lower manufacturing costs of this engine as compared with the air-injection or true Diesel, most of those firms engaged in the production of the latter type have devoted a deal of attention to the cheaper engine. Many of these builders have experimented sufficiently to enable them to evolve a workable solid-injection design. Others have either adopted an existing type or obtained rights to build European designs. However, in the opinion of many, European designs do not possess sufficient merit to justify the heavy license fees demanded. A few Diesel builders contemplate actively engaging in building the solid-injection engine of moderate powers, while others are marking time until conditions are more favorable. The Diesel builders are generally inclined to eliminate the small Diesel sizes and either to abandon sales effort in these sizes or place themselves in a position to offer an airless injection engine.

Since the solid-injection engine is still in the development stage, it has not become so standardized as has the Diesel. Subjects such as penetration of the air by the oil spray, atomization, air turbulence, etc., are debatable questions. One school adheres to the idea of obtaining vaporization and ignition by the oil being made to impinge on the hot piston head, this being an outgrowth of semi-Diesel practice. Other designers attempt to remove the oil spray from contact with any metal parts, obtaining vaporization and ignition through a core of hot air in the combustion space. Some are striving to obtain a primary ignition by combustion of the hydrogen content of the oil, followed by a slower burning of the carbon percentage. In the former types Otto-cycle combustion occurs, while the latter engine gives a rounded diagram indicating dual combustion.

While each engine builder has spent a large sum in experimental work, the solid-injection engine should be given a thorough analysis by some research body with the aim to clarify the confusion brought about by so many conflicting and at times fanciful claims. The action of Penn State College in taking up the question of penetration is a hopeful sign.

In the Diesel field the most marked tendency during the year is that of increased sizes. Engines of two thousand horsepower are no longer matters of wonderment. Several of the important builders are not only offering these large units but have become convinced that in the near future there will be a strong demand for engines of such capacities. One builder expresses the opinion that the minimum Diesel size will be around one thousand horsepower and intends to concentrate most of his sales effort on the large units. The excellent results shown by the large Diesels already in the field have caused central-station and industrial-plant executives to display a marked interest in the oil engine. Few plants below ten thousand horsepower have been constructed without the consideration of the oil engine.

The engines creating the most interest during the year have been the 3,000-hp. Bethlehem two-stroke-cycle engine, the 2,200-hp. McIntosh & Seymour unit and the 3,000-hp. Doxford solid-injection engines built by the Sun Shipbuilding Corporation.

Little that is new or untold has been noticeable in Diesel design during the year. The basic principles that determine the successful operation of the air-injection engine are well recognized. Manufacturers are not indulging in any radical changes in their designs. While the two-stroke-cycle principle for large units has received much consideration, no manufacturer has changed his position as to the relative merits of the two- and four-stroke-cycles. The double-acting engine has appeared as a workable machine in Europe, but American builders still adhere to the single-acting principle.

As in former years the oil-pipe lines and the central stations were the largest purchasers of Diesels. The Sinclair Pipe Line purchases gave considerable stability to the market, and the tendency to slash prices was not so evident as in 1922. However, oil-engine prices are below those existing in pre-war times, and a complete Diesel installation costs less than does a modern steam plant of equal rating.

Other lines, such as refrigeration, textile, marine and water works, have been purchasers of Diesels. A notable contract was the sale of Sun-Doxford engines to Ford for Great Lakes motorships. Sales, including those of solid-injection engines, totaled between eighty-five and ninety thousand horsepower.

The question of waste-heat recovery has been studied by a number of engineers. Several plants have been installed with means of recovering the waste heat in the exhaust. Unfortunately, the methods adopted have been somewhat crude in form and of low efficiency. With modern heater design the oil-engine efficiency is expected to reach 80 per cent, surpassing that of any known heat engine.

The semi-Diesel, as in former years, had a greater horsepower sale in 1923 than had the Diesel. The types of plants installing these engines have been varied, including cotton gins, small light plants, irrigation, water works, ice, textile, brickyard plants, etc.

Unlike the Diesel, the low-pressure engine is of comparatively small cylinder bore and several firms have been able to use production methods in the shops. Manufacturing costs have, as a consequence, been reduced, enabling the builders of the semi-Diesel to dominate the oil-engine field of units under 300 hp. Even though the fuel and lubricating-oil consumptions are high, the engine, by reason of its low capital charges, has a vogue in plants of even 900 hp. capacity.

There has been no increase in individual engine capacity, 300 hp. marking the maximum desirable rating of this design. No marked change in design has taken place, although practically every maker has made some improvement. Most of the changes have been attempts to improve the idling characteristics of the machine, since poor regulation at low loads has always been an inherent feature of the semi-Diesel.

Strangely, just as the Diesel builder is experimenting with the solid-injection engine, the semi-Diesel firms, almost without exception, are displaying a keen interest in the higher compression machine and are listing new designs, using higher pressures and eliminating the hot surface for ignition. Of general interest is the action of the Bessemer Gas Engine Co. This firm is one of the largest builders of semi-Diesel and gas engines in the country, and its engagement in the manufacture of the Bessemer Imperial solid-injection engine is not without significance.

Several builders of industrial gasoline engines are developing high-speed solid-injection designs. These are intended for industrial purposes, replacing the less efficient gas units.

The oil-engine locomotive both here and abroad has been given much attention during the year. Several drives have been tried out, the Lanz hydraulic and the electric drives proving to be the most attractive ones.

It is customary for engineers to assume that the gas engine is a thing of the past. To the contrary, several large blast-furnace gas engines were installed during the year, while the manufacture of gas engines up to 200 hp. was greater than in previous years.

Taken in its entirety the year has been a favorable one to the manufacturers of internal-combustion engines. While a few shops have been running with a much reduced force, most factories have been operating at full capacity. In fact, many orders have been lost by reason of the inability to give other than long-time delivery.

While builders do not enter the new year with as much immediate business as in 1923, nevertheless the industry has a healthy tone and there is every reason to expect the year's sales to eclipse those of 1923.

The Small Refrigerating Plant Predominates

IN QUITE striking contrast to the tendency of consolidation in so many industrial fields refrigerating engineers have been convinced that a number of small ice plants located in the center of the territory to be served will show greater economy than will a single large plant. The problem of distribution is important in all industries and, in the ice making field, makes up a considerable percentage of the total cost.

The willingness of central stations to give to ice plants a rate that is practically the central station's own cost, has enabled the small ice factories to come into existence. Reduction of building space, due to the absence of the boiler room and coal storage, lowers the cost of installation, while absence of smoke removes that objection to the existence of plants in residential districts.

In the year just passed, small-plant installations have predominated. While several immense cold-storage plants have been built, few large ice plants have come into existence, save when breweries have changed over to ice making.

The high-speed compressor has come into popularity largely by reason of its lower first cost. Electric motor drive has had its influence since the higher the compressor speed the cheaper does the motor become and the better its operating characteristics. The difficulty

of bringing the synchronous motor into step when starting the compressor has been solved, and this should lead to a greater employment of this type motor in ice plants.

The heavy poppet valve has, in the high-speed machine, given way to some type of light plate valve. This has increased the compressor's volumetric efficiency, and as a consequence many existing compressors have had plate valves inserted.

A more general use of welded joints is observed. Since most of the ammonia lost in a plant disappears through leaky joints, the reduced operating costs brought about by leak-proof joints fully justifies the slight increase in installation cost, when welding is carried out. Both acetylene and electric welding have been used to advantage. The former seems to be preferred for manifolds, etc., while the electric method is largely used for butt-end welding of coils and piping. A few plants have been installed in which there have been practically no flanged joints; even the condensers have been made up of welded shells and tubes.

Little improvement has been observed in the construction of condensers. The double-pipe and atmospheric types predominate. The several freak designs brought out several years ago are losing their one-time popularity. Manufacturers are finding that the simpler types are easier to handle and, taken as a whole, more efficient.

The use of two suction pressures is becoming quite common. To meet the demand, most ice-machinery builders are offering compressors equipped to handle two, and often three, different suction pressures. The popular method is by the employment of ports in the cylinder walls which are uncovered by the piston at the end of its suction stroke, during which the cylinder has been filled with gas at the lower suction pressure.

The output of small plants, ranging from one-half to two tons, has been enormous during the year. One builder states that in the coming year he expects to turn out three thousand such units. The installation of these machines in butcher shops, flower shops, etc., has had a marked effect upon the entire ice industry. Instead of selling most of his product in ton or half-ton lots and at low prices, the ice manufacturer must turn to the householder as the sole purchaser of ice. For this reason the ice business does not look hopeful.

The difficulty is increased by the appearance of a number of household ice machines. While the cost of operating such machines when interest, etc., are considered, is doubtless equal to the expense of purchased ice, the small machine eliminates the trouble caused by the handling of the purchased ice. It would seem that the ice-making industry is on the wane and that existing plants may be forced into the handling of cold storage.

The household machine has not been quite perfected and is still in a state of development. Present automatic controllers leave much to be desired, and the first cost is entirely too high. When manufacturers enter into real production, costs will no doubt show a decided drop, placing the machine within the means of most homes.

Ammonia as a refrigerant has never been deemed suitable for miniature plants, and even in large units carbon dioxide has enjoyed considerable popularity. Several firms make only carbon-dioxide systems and report an increasing sale to hospitals, hotels, etc. For the household machine ammonia has never been used.

Engineering Legislation and Society Activities

IN THE annals of engineering societies related to the mechanical field, 1923 will be a red-letter year. As previously stated, the foundation has been laid for a remarkable advance in steam-power generation. With a view toward improving thermal economy many radical departures from former practice have been suggested and are soon to be on trial in the plant. For the rapid crystallization of these advanced ideas the engineering societies of the country have been responsible. At various meetings throughout the year and among standing committees the problems have been attacked from different angles, comparisons made and limitations determined, so that there has been little hesitancy in starting out on well-blazed trails. This of course is the prime function of the engineering society, but it remains to be said that the work has been prolific and well done.

The formation of codes and standardization of equipment have continued, and there has been active participation in legislative matters having a bearing on the field. Local groups are taking an active part in solving community problems, and the Executive Board of the Federated American Engineering Societies, with the weight and prestige of the entire engineering profession behind it, is functioning in national affairs. Typical examples of its work are the nation-wide coal-storage investigation, to which considerable publicity has been given, revival of the public-works campaign backing the Brown plan for reorganizing the bureaus of the Interior Department and to this department transferring the United States Bureau of Mines and the Patent Office, and the recent resolution addressed to the government in behalf of forest conservation.

On standardization, work is continuing smoothly and in great volume. It has been reported during the year that the American Engineering Standards Committee is engaged actively on more than sixty projects. Of particular interest are the new standards for steel flanges and flanged fittings for pressures ranging from 250 to 900 lb. per sq.in. The American Society for Testing Materials, investigating the standardization of anthracite sizes, decided to use tentatively the names and sizes used in the trade. Specifications for refractories based on the results of service tests have been established by the Bureau of Standards. General specifications for the construction and installation of automatic engine stops have been made available by the Association of Iron and Steel Electrical Engineers. By the American Society of Heating and Ventilating Engineers a code on fan testing has been completed, and a tentative code of minimum requirements for the heating and ventilation of buildings is under preparation and is to be presented for adoption at the annual meeting during this month. An incident of the year that may

result in great good was the appropriation of $108,000 by the Carnegie Corporation for the study of engineering education. The work is to be done in co-operation with the Society for the Promotion of Engineering Education.

In legislation of engineering interest the Colorado River compact has not been ratified by the Congress owing to the failure of the legislature of Arizona to take definite action. By the other six states interested this unique peace treaty has been legally indorsed, so that final action awaits the convenience of Arizona.

Similar co-operative action between the New England and Middle Atlantic States is to be anticipated. Late in the year, upon the invitation of Secretary of Commerce Hoover, the public-utility commissioners of these states met for preliminary discussion of the steps that properly could be taken by federal and state authorities in the promotion of superpower development. The commissioners were unanimous in the desire to cooperate and bring about a free flow of power between their respective states. It was agreed that the engineering problems had been solved, and to eliminate the legal difficulties remaining, a uniform statute to be presented to the respective legislatures or a treaty between states was the solution offered. Final decision was reserved for an early meeting to which all interested parties would be invited.

In Pennsylvania Governor Pinchot's comprehensive program for power legislation was completed by the passage of the general power bill and the companion condemnation bill. In this legislation a most significant provision is for the creation of a giant power survey board to co-ordinate the water-power and fuel resources of the state and join this common reservoir of power to the interconnected transmission lines of the Northeastern States. The launching of the survey followed soon after the enabling legislation, with Morris Llewellyn Cooke, a consulting engineer, of Philadelphia, appointed as director.

It is quite evident that this general movement toward co-ordinating power resources is gathering momentum and soon is to become world-wide. National boundaries no longer introduce a barrier, for in July of this year London is to have a world power conference. American and European participation, with the exception of Russia and Germany, has been arranged, a tentative program has been announced and prospects are bright for a most successful gathering. The objects of the power conference have been expressed previously in these columns.

Two years later an international engineering congress is to be held in Philadelphia at the time of the Sesqui-Centennial Exposition, which is to feature progress in applied science and industrial arts. The congress has been planned to bring closer together the engineers of different countries, fostering a better understanding of the relation of the engineer.

Honor Roll for 1923

As a concluding feature of the review it has been customary to cite briefly honors conferred for exceptional service in engineering and allied fields. Shortly after the first of the year the many notable engineering achievements of Benjamin G. Lamme, chief engineer of the Westinghouse Electric & Manufacturing Co., were recognized officially when he was presented with the Joseph Sullivant Medal by his alma mater, Ohio State University. Mr. Lamme was the first person to receive this medal, which is to be awarded every five years for notable achievements on the part of a son or daughter of the university, in the fields of literature, philosophy and art as well as in science and engineering.

Another "first presentation" was that of the Coffin Medal to the Southern California Edison Co. It was made by the foundation created by the General Electric Co. for the most notable contribution to the development of electric-light and power service during the year. Other N.E.L.A. prizes awarded were the Doherty gold medal for the best paper of the year to G. Bertram Regar, of the Philadelphia Electric Co. "More Business Through Better Lighting" was the subject of his paper. A. H. Heitzler and S. R. Finley, of the Ohio Public Service Co., of Massilon, were awarded the Harriet Billings prize of $50, donated by Arthur Williams, of New York, for their joint paper analyzing the consumption of and revenue from lighting customers.

John R. Freeman, past-president of the American Society of Mechanical Engineering, was awarded the Society Medal for eminent service to engineering and manufacturing by his work in fire prevention and preservation of property. Mr. Freeman's Fire Stream Tables and his design of Underwriter's steam fire pump are well known.

From Stockholm, Sweden, it was announced recently that the Nobel prize for physics had been awarded to Dr. R. A. Millikan, of the California Institute of Technology. Earlier in the year Dr. Millikan also had been winner of the Edison Medal.

The first award of the Sir Robert Hadfield $1,000 prize for the best paper presented before any engineering society in the United States on fuel conservation as applied to the iron and steel industry, was made last year, G. R. McDermott, assistant chief engineer of the Illinois Steel Co., and Charles L. Kinney, Jr., of the same company, were the joint recipients. Mr. McDermott is chairman of the Combustion Committee of the Association of Iron and Steel Electrical Engineers, and the paper on which the award was made, had been presented before that society.

In honor of their first national president and founder, Henry D. Cozens, the National Association of Stationary Engineers unveiled a memorial monument at Fairmont Cemetery, Newark, N. J.

Winners of the Westinghouse War Memorial Scholarships for 1923 were as follows: George E. Doty, of Pittsburgh, electrical engineering, Carnegie Institute of Technology; Lawrence B. Biebel, of Oakmont, Pa., electrical engineering, University of Pittsburgh; Paul M. Williams, of Wilkinsburgh, Pa., electrical engineering, Carnegie Institute of Technology; Lee P. Doyle, San Francisco, electrical engineering, Ohio State University.

In the societies and associations closely allied to *Power's* field the honor of leadership is as follows:

Society	President
American Engineering Council of F.A.E.S..	Mortimer E. Cooley
American Society of Mechanical Engineers.	Fred R. Low
American Institute of Electrical Engineers.	Harris J. Ryan
Association of Iron and Steel Electrical Engineers	R. S. Shoemaker
American Society of Refrigerating Engineers	G. A. Horne
American Society of Heating and Ventilating Engineers	H. P. Gant
Engineering Foundation	Charles F. Rand
National Electric Light Association	Walter H. Johnson
National Association of Stationary Engineers	Royal C. Holbrook
National Association of Practical Refrigerating Engineers	E. J. McCormick
National District Heating Association	F. B. Orr
American Order of Steam and Electrical Engineers	Charles Berger
American Boiler Manufacturers' Association	E. R. Fish
Stoker Manufacturers' Association	J. C. Worker

Approaching 1924 with Confidence

WITH the date of this issue another year will be entered upon. A checking up on the twelve months just past shows the greatest period of prosperity ever experienced in this country. True, there have not been the pyramiding of prices both for labor and materials and demands out of all proportion to production that characterized the war period, but experience has shown that such conditions do not represent sound prosperity, but only an inflated condition that is dangerous to business stability. Though 1923 may have lacked much of the spectacular experienced during the boom war years, nevertheless production in many respects exceeded the maximum for the war-time period. Not only are improved conditions found in industry, but government estimates show that the farmers of the country will receive approximately one billion dollars more for their products in 1924 than for the preceding twelve months.

Business conditions are probably better reflected in the railroads than in any other way, since every industry must deal with this method of transportation. According to the Interstate Commerce Commission's report to Congress, during the first nine months of 1923 the volume of freight handled increased 31.1 per cent over the corresponding period for 1922, 2.9 per cent over the same period in 1920, which marked the previous record, and 4.8 per cent over the first nine months of 1918, which was the year of maximum traffic during the war.

Europe is still a disturbing factor, and conditions have not made much progress toward a settlement of the differences between the nations involved. A number of changes have taken place, but it would be difficult to say at this time whether they are for the better or the worse. However, the recently appointed committee to examine German finances and the apparently changed attitude of the German nation toward its obligations give a ray of hope that by the end of 1924 some real progress will be made toward getting Europe back into a more settled condition.

It is to interpret the demands for power that the power companies and power equipment manufacturers of the country must lend themselves. Last year saw unprecedented activities in this branch of the country's industry, with a power shortage in many sections of the nation. New projects were reported that represented five million kilowatts of large generating equipment and an investment of one-half billion dollars. If the small projects and industrial plants are included, this figure is greatly increased. To absorb this power will require a continuation of the nation's business activities, and present conditions merit the conclusion that the power industry can enter upon the next twelve months with confidence that its unprecedented expansion during 1923 will be justified.

Ash from Powdered Coal

WHEN pulverized coal is delivered to a modern boiler furnace, the diameter of each particle is in the order of one two-thousandths of an inch or less in diameter. The ash resulting from the combustion of such particles must be of extremely small dimension. In a well-regulated furnace it is improbable that any coal particles can pass through unburned, and furthermore, as the air supply is under good control, there should be no unburned distillation products, ordinarily known as soot, to pass up the chimney. The final character of the ash will depend on its composition and fusing temperature. High furnace temperatures are a rule, and ash of low fusing point, particularly if high in iron, will become liquid during its passage through the furnace. If its density in the liquid condition is sufficiently great or if it strikes and fluxes with another ash particle, it may become too heavy to remain in suspension and, on falling through the water screens, will solidify and drop into the ash hopper as solid inert sand-like material.

If the liquid ash remains suspended in the furnace, it will solidify on giving up its radiant energy to the cooler boiler tubes as it is carried along by the gases. This dense particle can be readily removed by a fan of the cindervane type. An ash particle of high fusing temperature offers more difficulty. It will be a light feathery mass that responds very little to centrifugal separation and is, therefore, hard to remove from flue gases. Water sprays should prove of some value in removing this material.

A considerable portion of the ash is deposited in the ashpit, in cinder pockets in the boilers and economizers while fans can remove a large percentage of the remainder. Hence there can be a relatively small amount of ash discharged from the chimney. This ash dust consists of fine particles that do not smudge like soot and are far less objectionable. This will be apparent as the ash generally consists of alumina, silica with some iron oxides.

The presence of ash in the flue gases leaving the chimney has been used as an argument against powdered coal. It is well to remember in this connection that the public as a rule little realize the quantities of soot and ash that are poured out of stoker-fired chimneys, particularly those employing heavy forced draft. No serious objections have been raised against powdered coal ash by property holders adjacent to plants using this fuel.

However, the atmosphere of our cities is becoming more and more polluted each year. It is the duty of the power engineer to aid in improving this condition. Hence the total elimination of ash from the flue gases of powdered-coal plants is a desirable aim. It will appear from the preceding that this will be a costly process unless some value can be given to the ash as a byproduct.

To what useful purpose can such finely divided material be applied? This is a problem worthy of much earnest study, for even the ash from ashpits is a nuisance in many cases and, on account of its fineness, hard to dispose of at low cost. Several uses have already been found, but more must be developed to consume the quantities that will soon be available. It is quite possible that this fine ash may replace more expensive materials in many industrial processes.

Turn on the Light

ILLUMINATION is a bigger factor in boiler-room operation than is generally appreciated, yet far too many boiler rooms remain inadequately lighted. The science of illumination has not yet progressed into the average boiler room, while the creed of better lighting, more light more carefully placed and scientifically applied, has found rapid adoption in factories and offices, stores and homes.

Light has a psychological as well as a physiological effect. Many conditions exist in the darkness that would not be tolerated in the light of day. Leaky valves, defective pipe coverings that may waste several tons of coal per year exist unnoticed in the shadows and dark places where adequate illumination would show them up. Corrosion, unseen and unsuspected dangers and insidious wastes go on in the dark. Many accidents in power plants are due to stumbling and falling over obstacles. Adequate illumination would alleviate if not prevent these.

Why is it that lighting fixtures are so often ill-adapted to boiler-room use? They collect dirt readily instead of offering minimum surface to dirt and dust. They are troublesome to clean instead of being easily cleaned. In far too many instances the lighting units are unwisely placed, so that what light there is constitutes a glare that shines in the men's eyes instead of casting illumination upon the object it is desired to see. Thus the light does harm instead of good. Flow meters, draft gages, gage glasses are all more valuable when well illuminated. Make it easy if you want it done is a terse saying that applies to the boiler room.

The lighting system should be planned and laid out with almost as much previous thought and consideration as is devoted to the steam piping. It should be designed to provide adequate general illumination to make the entire plant safe against gloom and glare, stumbling and falling, and to permit work to be performed comfortably and accurately. Instruments and equipment should be illuminated by local lighting units. Lastly, facilities should be provided to permit extension lights to be quickly used.

Normalizing Steel Valves and Fittings

STANDARDS for pipe fittings at higher pressures and temperatures, which are now under consideration, deal extensively with materials and methods of manufacture. It is highly important to remove internal strains, particularly in steel castings. The specifications usually employ the word "normalizing" in preference to the familiar term, annealing.

In removing internal strains, the process referred to as normalizing is superior to annealing, inasmuch as it leaves greater strength in the material. However, we are confronted with the fact that there is now no standard definition of "normalizing," and published references to this are likely to conflict with one another.

Conditioning of steel originally included tempering and annealing. We are not here referring to case hardening. During the last fifteen years the term heat treatment has been employed to include tempering and other processes. It should, in all probability, include annealing and normalizing. However, it is applied commercially in many instances to the form of treatment where steel is heated above the critical point and quenched. It may or may not be then drawn back to another condition or temper, by the application of more heat and perhaps additional quenching. This corresponds to "tempering," and a wider use of the term resulted notably from war manufacturing. The critical temperature is where a great structural change takes place. Here a large amount of heat must be applied to increase the temperature one degree, in comparison to a smaller amount necessary at lower temperatures. For tool steel this is near 1,400 degrees F., and for machine steel, about 1,550 degrees.

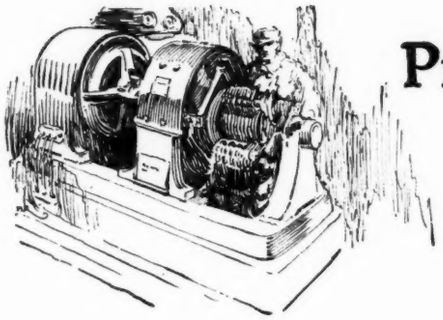
The process of annealing, as ordinarily understood, imparts a maximum of softness at the expense of strength. It also removes internal strains. This includes heating above the critical point and cooling very slowly, such as twenty-four to forty-eight hours.

Normalizing has been developed for the purpose of removing internal strains without sacrificing strength to the extent which annealing would. It restores normal conditions as much as possible. Here heating is carried above the critical point but cooling is fairly rapid, such as would occur if the article were cooled in air or with a light covering of ashes. The structure usually produced by annealing is "sorbite," which presents certain characteristics when under microscopic examination. Normalizing derives its virtues largely from a structure called "troostite," which is present in an appreciable degree as a result of more rapid cooling.

On the March

FOR the average operating engineer it has been a good year. He has found himself in a live profession where growth is rapid and based, to a larger extent than is true in many other lines of work, upon real service in meeting the economic needs of the country. Cheap and abundant power is one of the foundation stones of our national prosperity. The general recognition of this fact means increasing respect for the engineer as long as he continues to progress.

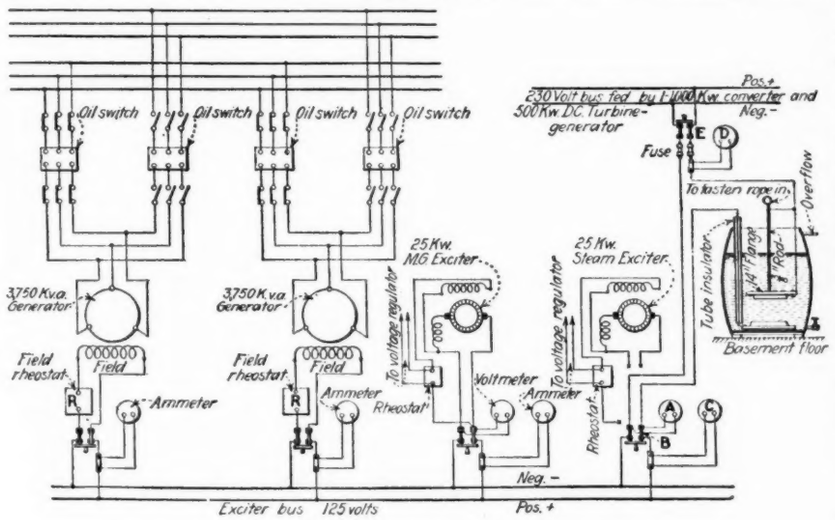
While individual engineers here and there will continue in the old rut, the profession as a whole will certainly progress. Its momentum is too great to be stopped. Hundreds of trained men are attacking the problems of design in a thoroughgoing scientific manner. As a result further improvements in economy are inevitable. The same attention is being given to the two objectives of good operation—dependability and low power cost. The greatest national gains in operation are to be expected not so much in improving the performance of the record-breaking plants as in cutting down the lead of such plants over the average. This sort of improvement will come to the extent that the rank and file of operating engineers keep records of plant performance and study these records critically in the light of what other plants accomplish under similar conditions.



Practical Ideas *from* Practical Men

Using Water Rheostat To Obtain Emergency Excitation

In our plant we have two 3,750-kva. turbo-alternators, one 25-kw. motor-driven exciter and one 25-kw. steam-driven exciter operating at 125 volts. There are also one 1,000-kw. rotary converter and one 500-kw. direct-current turbine-driven generator operating at 230 volts. On account of taking the steam exciter out of service for a general overhauling, a water rheostat was connected between the 230-volt busbars and the exciter system as indicated in the figure. The two were operated in parallel for 24 hours, also by taking the motor-generator set off the line and allowing the excitation current for the alternators to be supplied through the water rheostat alone, before dismantling the steam exciter. This was considered a fair test, and the arrangement gave satisfactory results in every way.



Exciter and Water-Rheostat Connections

It was found when paralleling the 230-volt bus with the 125-volt motor-generator set, that with switch *B* open the voltage indicated by voltmeter *A* would be high with fresh water in the barrel and the electrodes about 12 in. apart. This meter has a range of 0 to 150 volts, and the needle would throw nearly across the scale. When switch *B* was closed, the voltage became normal, or that of the motor-generator set, with ammeter *C*, indicating zero current. To build the load up through the water rheostat, salt was sprinkled into the barrel until the load was equally divided between the rheostat and motor-generator, with the latter controlled by the voltage regulator. Enough water was allowed to run into the barrel to make up for the evaporation and to keep down the temperature of the solution. Just as good regulation was obtained on the alternating-current generators as when the two exciters were used.

To take the water rheostat out of service, water was run into the barrel to weaken the solution and the load would gradually shift over to the motor-generator set. This was done because it was found that with 110 amperes flowing through the barrels, the load could not be reduced low enough by raising the top electrode. To operate the water rheostat without the motor-generator set, the two were first paralleled and salt added to the barrel until all the load shifted to the rheostat, when the motor-generator switches would be opened, the one on the generator being opened first. When excitation current was supplied through the water rheostat, the voltage of the alternators was regulated with the field rheostats *R* and by the amount of salt in the water rheostat, and we were able to hold the voltage on the alternators as steady as was possible with excitation current supplied from the exciters operating without the voltage regulators.

To prevent the water from boiling excessively, a small amount of water was kept running through the rheostat all the time. On a 48-hour run about 6 lb. of salt was used to make up the loss in the water running from the rheostat.

Ammeter *D* at switch *E* was put into the circuit to detect any current leakage from the water rheostat. As long as ammeters *C* and *D* read the same, there could be no current leakage from the rheostat, but a high reading on *D* would indicate leakage. However, no trouble was experienced from this source. As the plant is generating nearly 100,000 kw.-hr. a day, it is considered that the water rheostat has well repaid the cost of its construction since it was built from parts gathered up around the plant. The rheostat has not only helped carry the exciting load, but in case of the plant going dead it would make possible getting back into service again without the steam exciter. The rheostat also allowed taking the motor-generator set off the line for inspecting, cleaning and repairs.

The rheostat consisted of an oil barrel with an overflow pipe near the top and a short pipe and valve near the bottom, the latter for draining the barrel when desired. Two 14-in. cast-iron flanges were used for the electrodes. One was placed in the bottom of the barrel and connected to one side of the line. This line

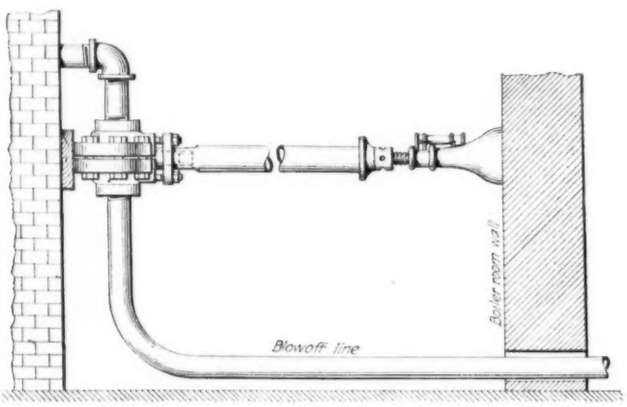
was brought out of the barrel through a piece of rubber hose as extra insulation to prevent short-circuits in the barrel. A ⅜-in. iron rod was attached to the top electrode and a rope attached to the top end of the rod. The rope was passed through two overhead pulleys and a counterweight connected to its end about equal to the weight of the electrode and cable so that the electrode would remain in any position it was moved to. A stop was placed on the rope so that it would strike one of the pulleys before the electrodes could come together and cause a short-circuit.

C. D. DISPENNETTE, Steam and Elec. Eng.,
Newport, Ky. Andrew Steel Co.

Repairing Blowoff Valve with Boiler in Service

When blowing off one of our boilers recently, the stuffing box on the blowoff valve began to leak excessively, and when the engineer attempted to draw down the gland, he stripped the threads on one of the studs. The leak then became so bad that it was necessary to have it stopped with the least possible delay. The engineer concluded that the only way to do this was to take the boiler out of service. This meant steaming up another boiler. Before doing this, however, he called the chief engineer, who worked out a plan for renewing the stud without removing the boiler from service.

He first secured a piece of pipe that would slip over the valve stem and cut two slots in the end so as to pass by the gland studs and nuts. After placing a block between the valve and the boiler to prevent any stress on the blowoff connection, he put the pipe in place over the valve stem and forced down the gland by using a



How gland was held in place while renewing stud.

screw jack against the boiler-room wall as shown in the illustration.

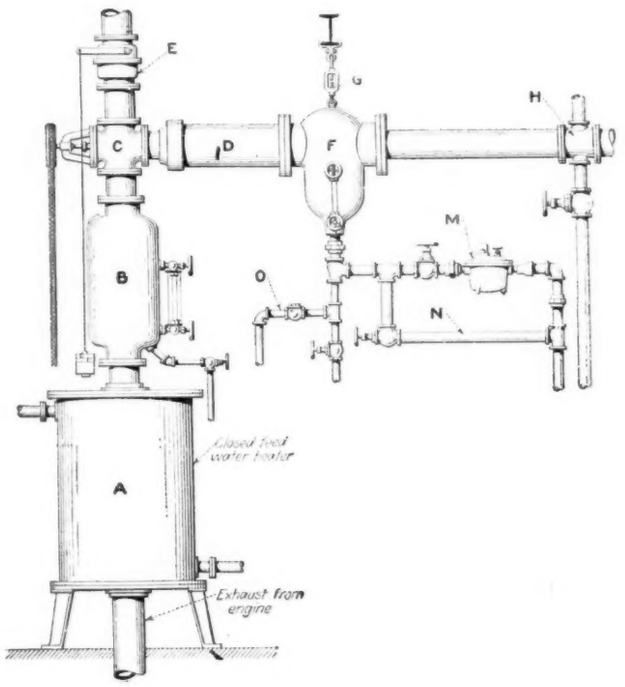
The renewing of the stud required only a short time, and by overcoming the trouble in this way considerable time and expense were saved. R. TOMACHEPTY.

Brenham, Texas.

Using a Suitable Separator

A closed feed-water heater, through which steam from an automatic engine passes, is illustrated at *A*. To convey steam to and from this heater, 5-in. piping is used. A 5-in. separator is shown at *B* which was satisfactory so long as the load on the engine was light, as no oil passed through it for several years. Later, when the load was doubled, the exhaust steam traveled much faster, and this caused considerable oil to remain in the steam, and it settled in a receiver which formed a part of a heating system.

A cross-valve is shown at *C*. When it is closed, the steam goes to the atmosphere, and opening it allows it to go through *D* to the heating system. This valve is controlled by a chain from the floor, therefore it is not



Large separator in heating line effectively removes oil from the exhaust steam

necessary to climb a ladder for this purpose. The back-pressure valve *E* is weighted in the ordinary way except that the weight is lowered by means of a stout wire to about four feet from the floor.

A section of the 5-in. pipe was cut out and a piece of 8-in. pipe substituted at *D*, also an 8-in. separator at *F*. As the area is thereby increased more than 2.5 times, the velocity is decreased in direct proportion. This separator was suspended from the ceiling by means of a turnbuckle *G*. When it is desired to examine the internal parts of this separator and clean it, the turnbuckle is removed and a pair of chain falls substituted. When the bolts are removed from the flange joints, the separator may be lowered to the floor.

On the discharge side of the separator the pipe is reduced to 5 in. and a 2x5-in. cross inserted at *H*. This provides a way for testing the steam. If allowed to condense in the large drip pipe shown, when drawn off it provides a sample from the bottom of the pipe. If steam is drawn from the top, a dry sample is secured.

A steam trap three sizes smaller than the piping was inserted at *M* with a bypass at *N*. The trap is generally large enough, but if it is not (for some special occasion), the bypass may be used. A cold-water pipe is used to wash out the piping and the lower part of the separator. A check valve prevents the return of any of the water. W. H. WAKEMAN.

New Haven, Conn.

Comments from Readers

Starting Synchronous Motors Automatically

I was much interested in the article, "Automatic Starters for Synchronous Motors—Frequency-Relay Type," which appeared in the Oct. 16 issue of *Power* on page 605. There is much in this article that is of interest in describing this particular type of starting equipment. On page 606 it is stated that "In the synchronous motor the squirrel-cage winding is not active except during the starting period when the motor is running below synchronism. This makes it possible to design the squirrel-cage winding of the synchronous motor so that the starting current is much less than it would be on a squirrel-cage induction motor of corresponding rating and speed." On page 608 the statement is made that "Should the motor drop out of step for any reason, the field current will be cut off by the frequency relay closing and opening the field contactor when the motor's speed is approximately 5 per cent below synchronism. The field contactor will remain open until the motor attains a speed where the frequency relay opens and closes the field contactor circuit."

From the foregoing it is obvious that the squirrel-cage windings are not designed for, or intended to be used as, running windings. Yet if the motor drops out of step while pulling its load, the frequency relay and field contactor throw onto the squirrel-cage windings the duty of serving as running windings while trying to pull the motor back into synchronism. Unless some provision is made for removing the load from the motor, how is the squirrel-cage starting winding going to pull the rotor up to the synchronous speed so that the frequency relay and field contactor may operate? It might be well to bear this point in mind and to avoid at all times any attempt to run the motor any length of time on the squirrel-cage windings. If the control is to be automatic, why not go a step farther and provide means of keeping the motor off the line until conditions are normal?

In one case in mind, the leads from the field contactor were broken, the motor started as usual and came up to speed, the load was applied and the motor continued to run on the squirrel-cage winding until the winding burned up and was thrown out of the slots by centrifugal force. As the load was only 75 per cent of the motor rating, overload relays would not and did not remedy matters.

In another instance the motor, after attaining synchronous speed, refused to pull into step because of some misadjustment in the direct-current field contactor, and the operator attempted to close the switch with a small stick, but only succeeded in breaking the point of the stick off and wedging it into the contactor mechanism so that a contact was impossible, yet to all outward appearances the switch was properly closed. The operator neglected to look at the direct-current ammeter in the field circuit, and the resulting damage to the rotor was the same as in the previous case.

These examples are related to indicate the possibility of damage which might result, even though neither the motor nor the control apparatus were directly at fault. The engineer who designed the motors cannot be criticized, since the squirrel-cage windings were made for starting duty only.

We are operating twelve motor-generator sets furnishing direct current for trolley service. Both the alternating- and the direct-current ends of the sets are automatically controlled and regulated, even including thermostats on the machine bearings. These machines are all located underground in small buildings, which are kept locked, only the electrical inspector and other authorized persons being able to gain entrance. The sets are started and stopped by push buttons that are accessible from the outside of the room and do not receive the attention of skilled operators, yet the service from the equipment is satisfactory. The service is severe, as peaks in the load are not subject to regulation and momentary overloads may be frequent, though not of long duration. No great operating difficulties have arisen, and so far the operating force has cared for all troubles.

To indicate the severity of the service, the counter on one automatic reclosing circuit breaker indicated that the breaker had opened 9,332 times in 300 working days. Normally, the breaker opens twice daily when the machine is shut down. It is thus seen that this breaker operated on an average over 30 times daily from presumably abnormal conditions—in other words, overloads. With a high dead-load setting and a defective dashpot and other relays and contactors improperly timed and adjusted, it was possible to put a heavy load on the set before it was in step. For instance, if the circuit breaker opened, the motormen might and often did put their controllers on the first point to indicate the return of current to the line. The synchronous motor might have been thrown out of step entirely and might be prevented from synchronizing itself properly. With the automatic reclosing circuit breaker properly calibrated for dead load, we have set all relays so that when the direct-current voltage reaches 210 the contactors will close, energizing the motor fields. This gets the motor into synchronism before the load is applied. The direct-current circuit breaker is set to close when the voltage reaches 250.

We have several of these machines with the direct-current ends in parallel and have established a bus voltage of 285 with the machines cold and have set the alternating-current inverse-time overload relays at 100 per cent of the stator current, to protect, so far as possible, against single phasing. As a precautionary measure I believe that this setting should be even lower, although our operating conditions hardly will permit. The setting of the time-element relay on the direct-current end should be made so that it will always open before the alternating-current relay opens. If the overload is on the direct-current machine, the breaker will protect it; if there is trouble due to overloads on the alternating end, the relays will give protection.

Philadelphia, Pa. W. A. PETERS.

Phasing Out the Generator for Parallel Connection

While operating a small light plant last year, I met the same difficulty as Mr. Curtis describes in the Nov. 27, 1923, issue,—that of phasing out a new three-phase 2,300-volt generator without a synchroscope.

The method we used is shown in the illustration. Lamps are connected between the leads of the old machine and those of the new or across the oil switch as shown in Fig. 1. If potential transformers are available, they should be used, but in our case they were not, so we used a lamp in series with a water resistance consisting of four two-quart fruit jars filled with plain water, the electrodes consisting of a short piece of No. 14 wire dipping into the water as shown in Fig. 3. The depth of the water should be adjusted until the lights come to full brilliancy, but not more. This can be done by trying them with too little water at first and then increasing the depth.

When both machines are running with normal voltage,

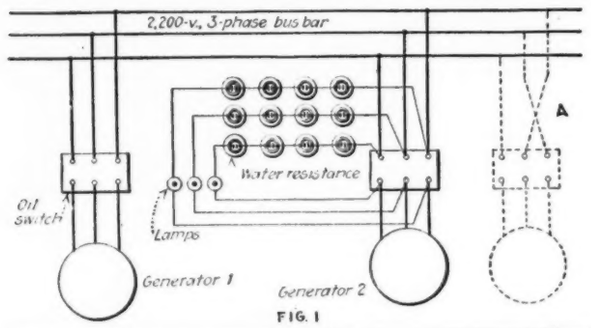


FIG. 1

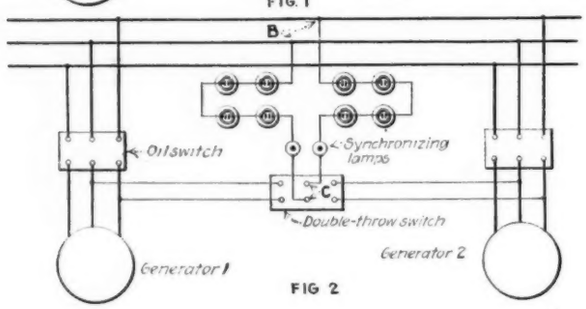


FIG 2

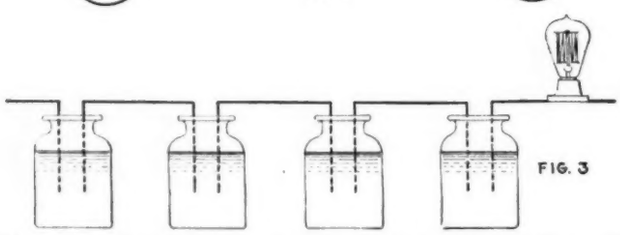


FIG. 3

Figs. 1 to 3—Diagram of connections for phasing out and synchronizing

Fig. 1—Lamps connected across generator switch for phasing out. Fig. 2—Connection for synchronizing with lamps "bright." Fig. 3—Water resistance used in place of potential transformers.

if the phases are connected wrong, as shown by the dotted lines at *A* in Fig. 1, the lamps will burn brightly and dimly in rotation. Two leads of one machine should then be interchanged, and if the connection is right, all three lamps will then go dim and bright together.

We never did buy a synchroscope, but continued to use this same arrangement for synchronizing, finding it satisfactory. The lamps were connected for synchronizing "bright." However, we were using small high-speed belted machines, and possibly synchronizing with lamps would not be entirely satisfactory with large slow-speed engine-driven units. No harm could be done by trying it, being very careful to choose the correct moment to close the switch connecting the machines together.

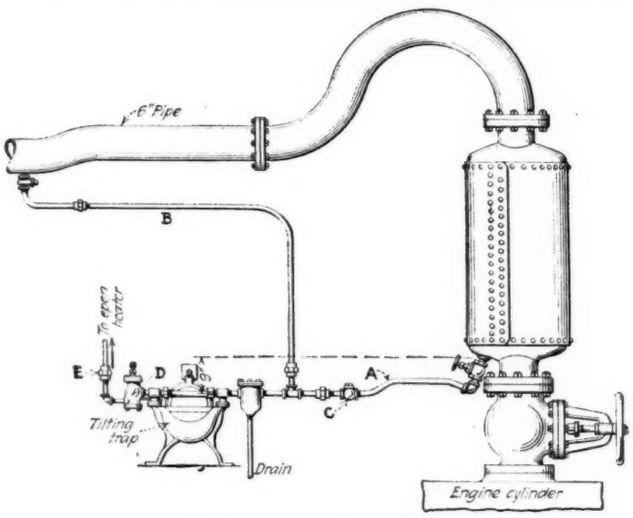
The diagram in Fig. 2 shows the lamps connected for synchronizing "bright." To synchronize with the lamps black, it is only necessary to transpose the connections at *B* or *C*. The water resistance is connected between the busbar and the lamps, and a double-throw switch is used for connecting the lamps to either machine.

East Pittsburgh, Pa. COLIN K. LEE.

Will Changing the Connections to the Trap Improve Its Operation?

The trap problem submitted by Mr. Van Keehern in the Dec. 4, 1923, issue, presents some features of special interest.

In my opinion a check valve should be installed in the pipe *A* at the point *C*, so that the condensate from the line *B* will not back up into the separator:



Arrangement of trap connections

otherwise the layout is all right. As far as the pipe *B* is concerned, the trap will work as well with it as without it. The location of the trap is low enough, but, of course the lower the trap the faster the water will be drained from the pipes.

I am inclined to think that his trouble lies not so much in the location of the trap or the arrangement of the piping as in the outlet valve *D*. I have found that about 90 per cent of the trouble in this type of trap was caused by leakage through this valve.

It is rather difficult to get this valve tight, and it must be absolutely tight to insure the satisfactory operation of the trap. I have found that sometimes the gasket directly beneath the valve seat was blown out, but more often the valve itself was leaking. To check this valve for leakage, disconnect a union on the outlet side as at *E*, and if any steam or water shows while the trap is filling the valve requires attention.

There is no need of a vent with this type of trap, for by tilting it once by hand, all the air will be discharged. These traps must be kept in good working order by packing the trunnions often and having them work easily. A. J. BELL.

Chicago, Ill.

Increasing the Speed of Air Compressor Reduces Capacity

Having read the article, "Increasing the Speed of Air Compressor Reduces Capacity," by J. M. Franklin, in the Nov. 27, 1923, issue, I think he is wrong in assuming that the trouble is caused by the small intake pipe.

In the first place the compressor is apparently rated too high, as a cylinder 16 in. in diameter by 16-in stroke, with compressor running 135 r.p.m., would have a capacity of approximately 503 instead of 550 cu.ft., as given; and as to the intake pipe's being too small, it seems to me that if the compressor was being worked up to capacity at 135 r.p.m., it should still have delivered the same amount of air at any speed above that.

Now by the same reasoning, when the speed was reduced to 90 r.p.m., the rising air pressure shows that more air went through it at the slower speed, and in my opinion it also shows that the fault lay in either the intake or discharge valves, or possibly both. As the design of the compressor is not given, it is difficult to

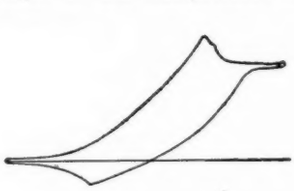


Fig. 1—Diagram obtained at high speed

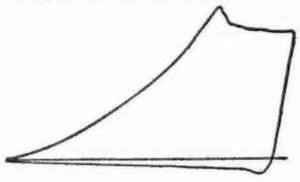


Fig. 2—Diagram obtained at low speed

draw any definite conclusions, but I surmise that in all probability the valves were heavy and the springs were too weak to close them promptly at each stroke and consequently allowed a large part of the air to blow back through the valves before they closed. The higher the speed the greater the opening of the valves owing to the higher velocity of the air through them.

I am convinced that had Mr. Franklin used the indicator on the first-stage air cylinder at the high speed, he probably would have obtained a diagram somewhat like Fig. 1, assuming that both intake and admission valves were at fault, while a diagram taken from it at the low, or present, speed would be somewhat like Fig. 2. The diagrams shown are free-hand drawings, and no attempt was made to draw them to scale, as they are but to illustrate a point. FRANK AVIS.

Clemenceau, Ariz.

Eliminate the Smoke

In the Oct. 23, 1923, issue of *Power*, under the title, "Eliminate the Smoke," I read as follows: "There is abundance of information available in the Bureau of Mines and in the files of engineering literature that will show one how to burn bituminous coal without objectionable smoke." Quite so, but why not be a little more definite and tell engineers and others who may be interested just where this information may be found?

Why not refer to the Jan. 10, 1911, issue of *Power*, in which there is an illustrated article that fully describes a cheaply constructed and efficient device that can be readily made by any factory engineer or master mechanic familiar with steam appliances, from material that can be picked up around most factories or plants? It consists essentially of three small steam jets installed at the front of a return-tubular boiler at the bottom of the uptake and by means of which some of the flue gases and excess air at high temperature is drawn from the breeching and directed into the furnace above the fire.

This device has never failed to accomplish the elimination of smoke; also one of the elements used has always materially reduced the fuel bills, regardless of what kind of fuel is used. And, by the way, this method of obtaining economy is just beginning to receive from engineers the attention its importance seems to merit, and the question is, why?

This method was first brought to the attention of engineers about 1882 (and after the invention of the smoke-prevention device already referred to) by the late J. C. Hoadley and published in Vol. VI of "Transactions of the American Society of Mechanical Engineers," pages 676 to 830 and showed an economy of from 9 to 15 per cent when used with anthracite, and a flue temperature of approximately 400 deg. F., whereas the flue temperature of most small factory boilers is about 600 deg. F. And may I be pardoned if I say this article is written with the hope of being of service to owners of small power plants, not because of any special sympathy for them, but in the hope of showing them a simple device within their means. The large corporations can afford to install mechanical stokers, which are quite efficient, and they can also employ a higher grade of engineering talent than many owners of small power plants think they can avail themselves of.

As most of us older engineers know, Mr. Hoadley was not a low-priced man, and naturally these thorough tests made by him and his assistants must have cost the New England Cotton Manufacturers Association, which financed them, a considerable sum of money; and the surprising thing is that in all these years so little attention has been paid to them, as in the writer's estimation this is the most promising field we have at the present day in which to look for increased efficiency in burning coal for the generation of steam.

As another evidence of the value of this practically unused element, may I refer to one of my recent articles as published in the July 10, 1923, issue of *Power?* In that article I gave a rough summary of a couple of tests of a highly efficient boiler. They were, however, confirmed by F. W. Dean, who gives more complete data in the Aug. 21, 1923, issue, but I have often wondered if even so astute an engineer as Mr. Dean realized all the elements used to obtain that unusual, for that day, extremely high duty. And how was it that in the several weeks that I had been experimenting before Mr. Dean's test I raised the efficiency so high that it was questioned, and even when Mr. Dean's first test was questioned the second test showed even better results?

And why was it that such eminent engineers as George H. Barrus, of Boston, and J. M. Whitham, of Philadelphia, who followed Mr. Dean, could not get quite so good results?

If I were called on to answer my own questions, I would say that it was due in large part to the unconscious use of this element I have been calling attention to, and which is made use of to perfection in the smoke prevention device referred to. W. H. ODELL.

Brooklyn, N. Y.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Exhaust Lead

What is the exhaust lead on a slide-valve engine? A. S. H.

Exhaust lead is the amount that the valve is open to exhaust when the piston reaches the end of its stroke.

Injury to Staybolts from Heavy Sounding Hammer

It is common practice of boiler inspectors to test the condition of staybolts by tapping them on one end with a sharp blow of a hammer weighing about one pound and without holding up the opposite end of the staybolt with a heavier hammer or other hold-back. Would not a hard swinging blow with a 4-lb. hammer and without holding back break or crack a staybolt otherwise suitable for a hydrostatic test pressure on the boiler of 200 lb. per sq.in., especially if the staybolt were under water? F. F. A.

A sharp swinging blow with a 4-lb. hammer, with or without holding back, would not be likely to crack or break a staybolt of ordinary proportions if the condition is suitable for a staybolt in a boiler that is expected to withstand a hydrostatic test pressure of 200 lb. per sq.in., which corresponds to a working pressure of about 133 lb. per sq.in. That method of testing is not to be recommended, however, as without holding back the severe pounding would be likely to disturb the screw threads and riveting of the ends and cause leakage that might be charged to fracture of the staybolt. Fracture of the staybolt from pounding one end, would be less likely to occur when the staybolt is under water.

Greater Lead for Valves of High-Speed Engine

Why should more lead and exhaust lap be given to the valves of a high-speed than to those of a low-speed engine? E. C.

Lead is given to the steam-admission valve of an engine to help in bringing the piston to rest for reversal of its stroke and to insure the presence of full steam-chest pressure in the very beginning of the stroke. Lead is given to the exhaust valves so there may be prompter release of steam after expansion, less back pressure during the exhaust stroke, and in single-valve engines more lap is given to the exhaust edge of the valve to obtain earlier closure and higher compression for cushioning effect in bringing the piston to rest at the end of the stroke and for filling the clearance space with steam that otherwise would have to be supplied by the admission valve for the return stroke. With high rotative speeds the lead of valves is greater, as less time is permitted for admission or release of the steam, and the exhaust is closed earlier sometimes by exhaust lap to obtain more compression for bringing the piston to rest at the end of the stroke, since for the same engine the inertia of the reciprocating parts increases as the square of the r.p.m.

Discoloration of Water Supply Used in Gas Calorimeter

We have a 12-in. diameter by 60-in. steel tank laid on its side for holding the supply of water used in our gas calorimeter. The tank never was galvanized and, from being kept filled with water most of the time within two inches of the top, it appears to be badly rusted on the inside, causing discoloration of the water and a troublesome deposit in the calorimeter. How can the rust be removed and prevented from returning, without removing the tank from its supports? E. M. H.

A solvent of the iron rust would also attack the material of the tank and would be likely to cause leakage at the joints. Thoroughly clean and wash out the tank, allow it to dry out as well as possible and strike light but sharp hammer blows over the outside. Then wash out the loosened material and allow the tank to remain filled for an hour with clean water containing about one-quarter pound of muriatic acid to a gallon. Having removed the loose material by another washing, fill the tank with a freshly mixed lime wash in which about ten pounds of casein powder has been thoroughly stirred to act as a binder. Draw off the lime wash and allow a few hours for it to harden on the interior surfaces of the tank. After a few refillings the water drawn through the tank should be as clear as the supply.

However, most water supplies contain earthy materials and metallic oxides that are precipitated when the water is allowed to stand, and when the draughts are at intervals, discoloration of the water caused by agitation of sludge deposited or raising the temperature of the water is likely to be attributed to rusting of the tank material when no better results would be obtained with a copper- or glass-lined tank.

Measuring Length of Connecting Rod

What is the best way to measure the length of an engine connecting rod? R. N.

The connecting-rod length is the distance from the center of the crosshead pin at midstroke to the center of the crankshaft. To save the trouble of placing the crosshead at midstroke, measure the distance from the center of the crosshead pin to the center of the crankshaft when the engine is on one dead center and then on the other, and half of the sum of these measurements is the length of the connecting rod. The most accurate method is to make a mark on the crosshead and a corresponding mark on a guide when the engine is on one dead center and also when on the other dead center

and tram from a stationary point to marks made on the wheel when the crank is on each dead center. Then remove the connecting rod and place the wheel and crosshead in corresponding dead-center positions, and with a light but inflexible wooden rod, take the distance from crankpin to crosshead pin, cutting off the rod to the exact length, or, by setting a nail or screw in one end of the rod if it is cut off a little shorter than the distance between the pins. Then to obtain the distance center to center of pins, caliper the pins and add half the sum of their diameters to the distance rodded between the pins. The measurements should be made in the same manner with the crank and crosshead placed on the other dead center, and if there is any discrepancy, the average of the measurements should be used.

Increasing Thickness of Flywheel Rim

If the thickness of a cast-iron flywheel rim is doubled, could the speed be doubled without increasing the danger of the rim's bursting from centrifugal force?

E. A.

The addition of material would increase the weight of the rim and thereby increase the centrifugal force in nearly the same proportion as the total strength would be increased. Increasing the thickness would increase the resistance of the rim against bending outward between the arms, but if the increase of thickness is obtained by increasing the diameter of the wheel, the centrifugal effect for a given speed also would be increased from having the center of the rim's cross-section farther removed from the center of rotation.

For most practical purposes it may be considered that, for the same number of revolutions per minute, the stresses per unit of cross-section would be unchanged and the flywheel would be made no safer against rupture from centrifugal force by increasing the thickness of the rim with material of the same weight per unit of volume and the same strength per unit of cross-section. Centrifugal force increases as the square of the speed and, from doubling the speed, the stresses from centrifugal force become four times as much. Since, with any speed, increasing the thickness of the rim does not decrease the stress per unit of cross-section, doubling the thickness would not reduce the danger of the rim's bursting at double the speed.

Operation of D Slide Valve

How are admission and release of steam accomplished by the D slide valve and eccentric of a slide-valve engine?

D. H.

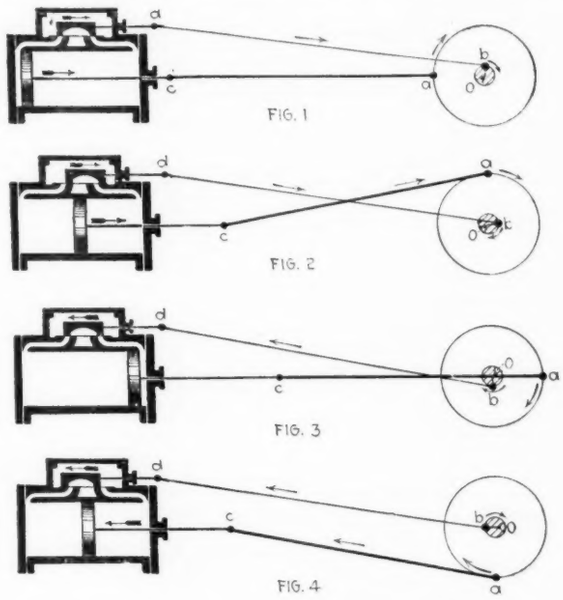
The ordinary D slide valve, without lap or lead, is of such proportions that one end of the valve uncovers a port for admission of steam from the steam chest to one end of the cylinder, while the other end of the valve seals off the steam chest from the port of the other end of the cylinder, and by the cavity or "D" form of the valve, the port that is thus sealed off from the steam chest is placed in communication with the exhaust.

The diagrams, Figs. 1 to 4, indicate how the valve is placed by the eccentric for different positions of the crank and piston during a double stroke of the engine. In each of the diagrams *Oa* represents the crank *Ob* the radius of the eccentric, *ac* the connecting rod; and *bd* the eccentric rod.

Fig. 1 represents the position of the piston at the beginning of a forward stroke. The valve is in position to begin movement in the direction of the arrow and for the outer edge to uncover the port for admission of steam to the head end of the cylinder. The valve is in its central position, and consequently *Ob*, the radius of the eccentric, is vertical, and all parts are moving in the directions indicated by the arrows.

Fig. 2 shows the positions of parts when the crank has moved approximately 90 deg. The piston is at or about the middle of its stroke, the valve has reached the extreme limit of its travel to the right, and the eccentric radius *Ob*, is horizontal. The left steam port is fully opened for admission of live steam to the head end of the cylinder, and the right steam port is fully opened for exhaust from the crank end.

Another crank and eccentric movement of 90 deg. places the parts as shown in Fig. 3, with the piston at the end of the stroke and the valve returned to its central position, ready to begin opening of the crank-end



Successive positions of D slide valve during double stroke of piston

port for admission of steam and the head-end port for release of exhaust.

Fig. 4 shows the piston at or about its central position on the return stroke. The crank is in the position *Oa*, and the eccentric radius is horizontal, as represented by *Ob*. The valve is placed at the farthest point of its travel to the left, with the right port fully open for admission of steam and the left port fully open for exhaust to occur from the head end.

With rotation of the shaft another 90 deg., all parts are returned to the position shown in Fig. 1. It is evident from the diagrams that for starting up from positions shown in Figs. 1 and 3, it is necessary to turn the engine sufficiently for admission of steam, and for maintaining rotation it is necessary to depend on the inertia of the flywheel or some other force, not only to carry the crank over dead centers, but also for the eccentric to move the valve from its central position.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses.—Editor.]

Trend of Hydro-Electric Development Toward Larger Units

COINCIDENTALLY with the starting of a 70,000-hp. hydro-electric unit at Niagara Falls, N. Y., preliminary designs for units of 100,000-hp. rating are on the drafting board, declared W. M. White, manager and chief engineer hydraulic department, Allis-Chalmers Mfg. Co., at a well attended meeting of the Boston Society of Civil Engineers, Dec. 19. In a masterly review of the growing dependence of civilization upon power the speaker touched upon the potential and developed hydraulic resources of the world and pictured the latest advances in plant and equipment design. Economic studies indicate that the workman who can direct the greatest amount of power will receive the greatest wage. The following table shows the relative development in three leading countries:

HORSEPOWER (STEAM AND WATER) PER CAPITA AND DAILY WAGES

	Population	Total Hp. Millions	Hp. per Capita	Average Daily Wages of Labor
United States	106,000,000	35	0.330	$4.75
Great Britain	46,000,000	9	0.195	3.20
Japan	56,000,000	2.5	0.045	0.99

It has been computed that to produce 70,000 hp. by steam would require the services of 1,500 men to mine, hoist, sort, load, transport on railway cars to destination, including repairs to rolling stock, and again to unload, store, reload, deliver and fire under boilers sufficient coal for this service. Fifty-three per cent of the total hydraulic power in the world has been developed in North America, this consisting of 9,000,000 hp. in the United States and 2,500,000 in Canada. The world's available supply of energy in water power on the basis of 75 per cent of the theoretical power available for 75 per cent of the time is 440,000,000 hp., of which 60,000,000 is available in North America, 50,000,000 in South America, 45,000,000 in Europe, 75,000,000 in Asia and 200,000,000 in Africa.

Classification of Developments by Heal Ranges

In studying the problem of selecting hydraulic machinery, four major ranges of head should be considered:

1. Standard Open-Flume Construction—This is generally used up to and including heads of 20 ft. Rarely is a spiral form used on this type of turbine. In some cases a nose or pointed obstruction is placed in the rear of the flume directed to divert the water smoothly into the guide chamber. The modern tendency toward larger units has made the vertical type more economical and efficient for the low heads. The tendency has been to increase the size under low heads, and as this has meant lower speed and greater generator costs, the demand has been insistent for higher speeds under the lower heads. Generator efficiency is poorer under lower heads. The high-speed propeller-type runner has met the situation well by providing practically double the speed previously possible on these low heads for a given power and head. The simplicity of the runner appeals greatly to those operators who had previously been troubled with trash and anchor ice.

2. A range of Heads from 20 to 60 feet—Within this range the tendency is to equip units with concrete spiral casings and to equip the turbines with outside operating mechanism. The design of the hydraulic machinery fixes the center to center of the units in the power house within this range, rather than the electrical design. For economical reasons a concrete spiral casing must be kept as small as possible. It has been the speaker's company's practice to place the nose of the spiral on the longitudinal center line of the power house. This provides that the water that passes downstream of the longitudinal center line of the power house in the spiral casing does not again pass upstream of this center line. The dimensions of the spiral may be made the least possible for a given limited maximum velocity of water.

3. A Range from 60 to 300 ft., or the "metal spiral" range—The concrete spiral has been constructed for heads considerably above 60 ft. and steel spiral casings for heads as low as 45 ft., with economical results. Within this range lies the greatest development for the future, 70 per cent of the world's water powers thus being included. One-half the total horsepower of turbines built by the Allis-Chalmers company during the last four years fall within this range.

The plate-steel circular-section spiral is being generally used for heads up to 225 ft., sometimes to 350 ft. The plate-steel spiral casing is a logical development, continuing the plate-steel penstock around the turbine. Cast-steel spiral casings are used throughout the upper limits of this range. The difficulties of casting the sections of these large spirals has been overcome by casting the speed-vane ribs integral with the spiral casing and multi-sectionalizing the latter. Means have also been provided of sectionalizing the speed ring from the casing. So far the cast-steel spiral casing has been used exclusively for heads between 300 and 850 feet.

The range of the impulse wheel overlaps that of the Francis turbine, beginning probably at 500 ft., coming into exclusive range at 850 ft., and having no upper limits except the strength of materials. The present upper limit of application is 3,000 feet.

The double overhung unit with a single jet on each wheel remains the standard and will probably be the leading type for several years to come. The efficiency of impulse wheels has been pushed up to remarkably high limits.

Draft-Tube Developments

The greatest advances in utilizing water for power purposes have occurred of late in the improvement of the form of the passages from the runner to the tail-race. As the percentage of energy discharged from runners has increased with mounting sizes of wheels the energy lost in draft tubes has also increased. This has forced setting the runner nearer the tail-water level than formerly. Larger diameters and shorter radii of curvature in curved draft tubes have been demanded; the high specific speed of runners has led to an increased whirl in the water leaving the draft tube. The hydraucone draft tube provides for radially extending passages in which the whirling water may be made to pump itself out against the tail water level, thereby increasing the wheel efficiency. Interest in draft tube design is now at "fever heat."

The hydraucone draft tube is not limited to a flat plate or flat bottom. It provides a means for regaining the discharged energy effectively within a short space measured in the direction of flow from the wheel, thereby saving excavation. A new form of curved draft tube for utilizing a portion of the hydraucone has given fairly good results. This type is characterized by the lowering of the roof of the draft tube to form a concentration at the discharge end of the bend. This type of tube, when used with a long section of a horizontally expanding draft tube, gives effective regain, provided the form of the curved tube is such as to provide for substantially parallel stream-flow lines of substantially equal velocity at the entrance to the horizontal portion of the expanding tube. The radially extending passages of the hydraucone draft tube provide for regain of the whirling water discharged from the runner when the turbine is operating at part load. Eighty per cent of the energy entering the hydraucone in velocity head is transformed into pressure head at the discharge.

Question of Specific Speeds

The formula, $N_S = \frac{5050}{H+32} + 19$, where N_S is the specific speed for a particular head and H the head, is convenient. As a rule, runners of higher specific speeds than those indicated by this formula will pit or erode and may do so below these speeds. In some cases it is more economical to select

higher specific speeds than those indicated in the formula, because in the relation of the cost of generator and its increased effieciency to the cost of repairs or replacemnts from pitting, the latter may be less. In selecting the limits of specific speed for a particular installation, the varying cost of the generator in relation to specific speed should be carefully considered. In the case of large generators the speaker's company has found that there is a definite point of flexure in the curve of cost plotted in respect to speed, and in large units this point of flexure frequently corresponds to a lower specific speed than the formula indicates.

Remote Control Making Rapid Progress

Admirable control of governors now available from distant points makes it no longer necessary to place the governor beside the generator within jumping distance of the station attendants. In large plants with large units the distances between the switchboard and the prime movers are too great for satisfactory manual control. Automatic shutdown devices are coming into general use. Devices have been installed on the governor whereby the closing of a switch at the switchboard will automatically close the turbine gates, apply the brakes, trip the circuit breakers and open the field switches on the main machine. The progress of automatic stations was then reviewed by the speaker who said that the greatest development of the next few years bids fair to be the heads of 50 ft. and below for automatic station service, hitherto outside the range of economical cost.

In response to inquiries Mr. White pointed out that by proper designing of bucket ribbing, vibration and noise has been practically eliminated in an impulse-type wheel with 22 buckets running 150 r.p.m. under a head of 1,050 ft., the prime mover being of the double overhung type, rated at 30,000 hp. and served by water jets 10½ in. in diameter. Each bucket weighs 1,200 lb., and yet there is virtually no noise discernible when standing beside the unit. Butterfly valves with metal packing strips are proving highly useful in obtaining automatic adjustment of packing to the shape of the housing in a 240-ft. head plant. The use of the single-floor design of power houses, as at the De Sabla plant in California, is finding considerable favor.

Governors for large units are being built with great sensitivity, a change of 0.001 in. in motion of flyball mechanism being sufficient to move the gates of the 70,000-hp. turbine lately installed at Niagara. The speaker said that in designing 40,000-hp. wheel units the problems of safety, governing and efficiency were far more difficult than in advancing from 40,000 to 70,000 hp. The governors of the large units will move the gates on a speed change of 0.1 per cent.

The limiting factors in increasing the size of waterwheel units are chiefly the clearance of parts in railroad transportation and the size of shaft that can be forged and machined. Ultimately, the speaker anticipates the use of the Francis turbine on heads of 900 to 1,000 ft. and 100,000 hp. ratings. Bearing problems have been so well solved in vertical units by Kingsbury that their popularity continues to be wide, and there are advantages in regard to the flow of water away from vertical units which tend to maintain their general use. Pitting may be due to nascent oxygen, although some authorities charge it against electrolysis. If occasion demands, the manufacturers will produce vertical impulse wheels.

Closing, Mr. White pointed out that the economical number of hydraulic generating units for an isolated station may run from two to four, but in interconnected plants it is permissible to forget the number of units and design for maximum cost economy. In Japan a law requires 25 per cent power reserve in new plants. The Niagara Falls tunnel, the speaker said, was built at less cost than open-cut construction on account of the facility with which regular excavating machinery could be employed.

Pulverized Fuel and Efficient Steam Generation

In a paper read at a recent meeting of the Institution of Electrical Engineers in London, England, David Brownlie reviewed the whole question of the application of pulverized fuel to steam generation. Extensive data were presented relating to the operation of the Lakeside Station at Milwaukee and the River Rouge plant of the Ford Motor Co. For comparison there were given the figures of the Dalmarnock Station at Glasgow, Scotland, which is fired with mechanical stokers and which is one of the largest and most efficient stations in Great Britain.

One of the chief impressions of the paper was the urgent necessity for the adoption in Great Britain of improved scientific methods, particularly in connection with the production of cheaper power and the application of pulverized coal to steam generation.

Mr. Brownlie gave as his opinion—based on his own investigations for over 15 years past into the operation of steam boilers in Great Britain, work that has included a detailed scientific investigation of the working of 400 different steam boiler plant installation, representing 1,513 boilers, in 41 different industries with an annual coal bill of 3,250,000 tons—that the average steam boiler plant efficiency throughout Great Britain is only 58 per cent. As a result also of a further personal inspection of nearly 2,000 boiler plants, equivalent to a consumption of 15,000,000 tons of coal per annum, his final conclusion is that the average efficiency with which 90,000,000 tons of coal is burned per annum in the steam boilers of Great Britain is less than 60 per cent, representing an avoidable loss, because of the lack of scientific methods, of no less than 20,000,000 tons of coal per annum.

In his opinion one of the chief difficulties in the proper consideration of the whole question is the fact that there is at present no satisfactory boiler testing code in the world. What is supposed to be the British standard code, that of the Institution of Civil Engineers, is hopelessly antiquated and out-of-date. The codes of the American Society of Mechanical Engineers and of the German Association of Engineers are both much better, but even these are not satisfactory. He suggested the formulation of a new International Boiler Testing Co. In his opinion the absence of such a code tends to considerable confusion in expressing the results, which may vary 2 or 3 per cent on this account.

Mr. Brownlie presented data showing the number of boiler plants with the total capacities now in operation and under construction in the United States, which he said in the course of a few months would be using a total of 3,400,000 tons of pulverized fuel per annum for steam generation, equal to half the capacity of the whole of the power stations of Great Britain put together; whereas in Great Britain there has been practically no headway at all, and even at the present time there is only one large boiler plant at work on pulverized coal, that of the Hammersmith Electricity Station, with three boilers of 45,000 lb. evaporation, together with a small installation at Peterborough and one or two odd experimental boilers.

The author gave it as his opinion that a serious investigation of the whole question of the use of pulverized coal in Great Britain is imperative, especially for large power plants. He stated that Great Britain will eventually have to submit the great part of its coal to low-temperature carbonization, which incidentally would result in a national saving of at least £200,000,000 per annum and render that country independent of the rest of the world for motor spirit, fuel oil, and Diesel-engine oil, together with sulphate of ammonia for the proper cultivation of soil, while the residual low-volatile fuel could be burnt in the pulverized condition at the highest efficiency.

For most air compressors a cooling-water pressure of approximately 20 lb. per sq.in. is usually sufficient, and if possible it is best to have the outflow water piping discharge into an open funnel. By this means both the quantity and temperature may easily be observed. It is best to adjust jacket water so that as it leaves it just begins to feel warm to the hand. Any more than this is a waste of water, and any less may quickly become hot and cause excess cylinder heating and oil carbonization.

Hoover to Speak at Banquet of the F. A. E. S.

Secretary Herbert Hoover of the Department of Commerce, President Nicholas Murray Butler of Columbia University, and Dwight F. Davis, Assistant Secretary of War, will be the chief speakers at a dinner in Washington, Thursday evening, Jan. 10, to be attended by engineers, public officials, representatives of the Army and Navy, educators and economists from all over the United States.

The event will be one of a series lasting a week in connection with the annual meeting of the American Engineering Council of the Federated American Engineering Societies. Secretary Hoover is expected to discuss the work of the Department of Commerce as it relates to the nation's vast engineering projects.

Dr. Butler will describe the growing influence of engineers in modern life and their influence on world affairs. Speaking on "The Industrial Preparedness Program of the War Department," Mr. Davis will tell how engineering organizations may be helpful in the execution of the national program. Dean Mortimer E. Cooley of the University of Michigan, retiring president of the American Engineering Council, will preside. Heads of national engineering organizations from New York and cities of the West and South, in addition to representatives of numerous local societies, will attend.

A central feature of the week's meetings is a Public Works Conference to be held on Wednesday, Jan. 9. Delegates from more than 200 engineering and allied bodies, including the American Institute of Architects, will be present.

The purpose of the conference is to urge the adoption by Congress of that part of the Brown plan of government reorganization which provides for the making over of the Department of the Interior, the proposed arrangement grouping the functions of the department under a Division of Public Works and a Division of the Public Domain. The United States Patent Office and the Bureau of Mines would be transferred from the Department of the Interior to the Department of Commerce.

Both Secretary Hoover and Secretary Work, according to an official statement of the American Engineering Council, are in favor of the plan. In a bulletin just sent to its membership throughout the country, the Council says:

> Executive Secretary L. W. Wallace was called into conference with Secretary Hoover and Secretary Work recently and told, in effect, by each of these Cabinet members that the engineers would be looked to as the dominating influence in the consummation of this plan, especially that part which had to do with the allocation of technical and scientific bureaus.
>
> This expression of confidence by two members of the Cabinet is another recognition of the place that the engineers have attained in public affairs.

Sessions of the American Engineering Council will be held on Thursday and Friday. Subjects to be considered include the report of the Committee on Storage of Coal, facts for which have been gathered by committees in more than 100 cities under the headship of W. L. Abbott, of Chicago, and proposed legislation relating to the coal industry. Reforestation, Patent Office reform, status of sanitary engineers in the Public Health Service, Secretary Mellon's tax reduction plan, establishment of a national hydraulic laboratory, engineering education, and relations with the engineers of other countries will also be discussed.

"It is contemplated," said the announcement, "that a complete plan will be developed for pushing government reorganization as it relates to engineering matters and as approved by the late President Harding."

Is There Enough Mercury for Mercury Boilers?

The Dec. 4, 1923, issue of *Power* described the Emmet mercury boiler which has recently excited the general interest of laymen as well as engineers. One phase of the problem lies outside the (present) field of power engineering. Reference is made to the question of the supply of mercury. In this connection the opinions of mining experts are of interest. The following comments are quoted from an editorial on the Emmet mercury boiler in the Dec. 22, 1923, issue of the *Engineering and Mining Journal-Press:*

> The conclusion to which we all leap is that if present experiments are successful, mercury will presently be used in all steam boilers. But to the student of the world's mineral resources there comes a query that may not present itself to the mechanical engineer: how about the supply of mercury?
>
> The Emmet boiler at Hartford holds about 30,000 lb. of mercury. The total production of mercury in the United States in 1919 was 1,601,000 lb., enough to equip only fifty-three boilers like the one already equipped, which has developed about 1,500 kw., or nearly 2,000 hp. In 1922 the mercury produced in the United States had fallen to 478,000 lb., or enough to equip sixteen boilers of the size of the Emmet installation at Hartford. This United States production was to be sure only about one-fifth of the average production for nearly twenty years: nevertheless, it is clear that these twenty years have skimmed the cream from our deposits.
>
> The world production of mercury in 1921 was only 4,451,000 lb., enough to equip only 148 boilers of the size of the Hartford plant. The total worlds' production for fourteen years from 1908 through 1921 inclusive was 110,337,000 lb., or less than half what would be required to change the high-pressure steam boilers of the United States alone to the mercury system.
>
> Enough statistics have been quoted to show how hopelessly inadequate is the hitherto-produced world's supply of mercury to meet the requirements of this suggested new industrial device. The question then arises whether increased demand would not bring on an increased supply. Beyond any question such a demand would bring about a greatly increased production, but this demand would have to be made in terms of higher prices for quicksilver. We quote currently about $60 per flask of 75 lb.: the average price in 1922 is given by the United States Geological Survey at $57.78, based on *Engineering and Mining Journal-Press* quotations for the year. Owing to the relatively small quantity of quicksilver produced, its price has been subject to wide fluctuations. For many years before the Great War the price was generally below $40 a flask. If the demand for quicksilver for boiler purposes grows, it is inevitable that a skyrocketing of prices will take place.
>
> In 1921 the United States, although producing only 6,339 flasks (475,425 lb.), still remained the third largest producing country in the world, Italy (including the Idria mine) being largest, and Spain (with the Almaden mine) second.
>
> It is evident, therefore, that there is little chance of the production of quicksilver being increased to the enormous degree of allowing it to be used in all steam boilers; also, that the use of the metal in even a few boilers is likely to cause an immense increase in the price.

Discarded Boiler Tubing Salvaged by Welding

The October issue of *Oxy-Acetylene Tips* told of the use of the welding and cutting torch for salvaging scrap boiler tubing, the salvaged tubing being put into service again in the form of welded pipe lines carrying oil, gas and low-pressure steam. In one case large quantities of scrap four-inch boiler tubing are being installed as part of a 28-mile welded gas line.

In general the operations consist of cutting off the split or corroded ends, straightening such tubing as may be bent or deformed, building up pitted places, and welding comparatively short lengths of pipe tubing into 30-ft. or 40-ft. sections for convenient and economical handling in the field.

In some cases where large quantities of this tubing are being reclaimed, the operation of cutting the damaged end of the tube has been standardized by the use of specially built tables and racks, and guides for both the pipe and the cutting blowpipe. For example, in one place the cutting blowpipe is held in a rack and the pipe turned by a helper. When it is desired to cut the pipe ends so they will be beveled for welding, the blowpipe holder is adjusted to hold the head of the blowpipe at an angle to the wall of the pipe.

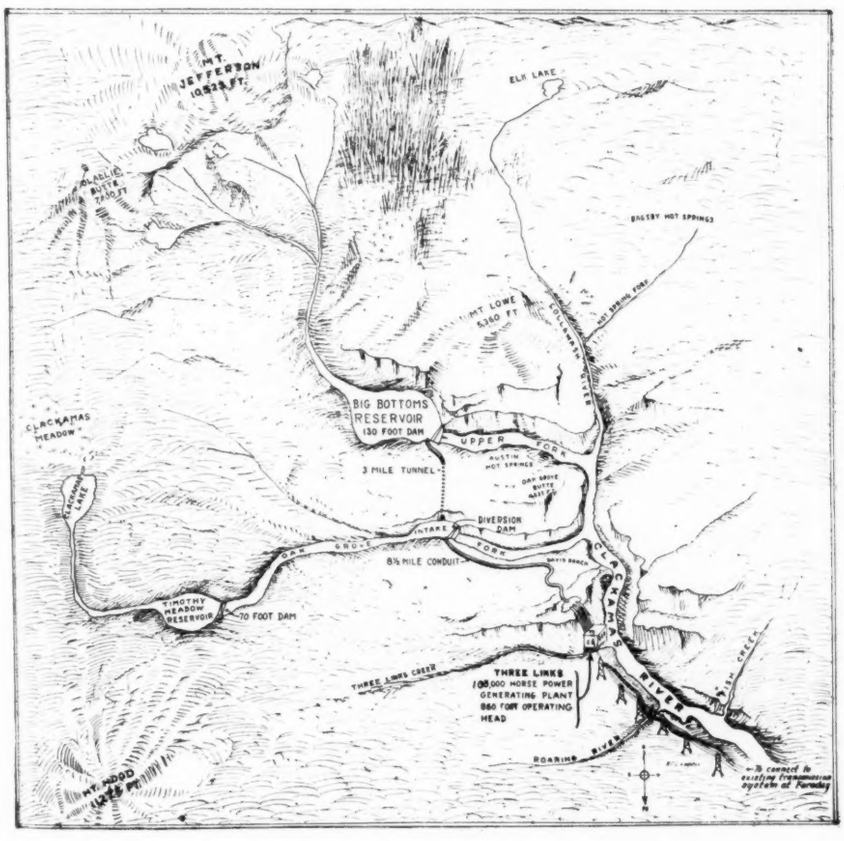
Oak Grove Station To Be in Operation by July, 1924

A new world's record will be established for high-head reaction-type hydraulic turbines when the Oak Grove project of the Portland (Ore.) Railway, Light & Power Company is completed.

Construction work is now in progress on a hydro-electric development which will have an ultimate capacity of 100,000 hp. The first unit, which is expected to be in service by July 1, 1924, will develop 25,000 kw. and cost about $10,000,000. The hydraulic turbine for this project, which has just been ordered, will be a 35,000-hp., 514-r.p.m., Francis-type, single-discharge unit, operating under a head of 860 ft., made by the Pelton Water Wheel Co. This unit will establish a world's record for a reaction-type hydraulic turbine. It will be similar to the Francis-type turbines at the Kern River No. 3 plant of the Southern California Edison Co., which are of 25,000 hp. capacity, operating under a head of 810 ft., and which have stood as the world's record up until this time for reaction-type turbines.

Six New York State Plants To Be Consolidated

The Public Service Commission of New York State has recently authorized the purchase, by the New York Central Electric Corp., of six gas and electric companies serving the section of the state southwest of Rochester. The Commission authorized this purchase on the ground that more efficieint service will be provided and that a larger amount of current will be available for lighting and power purposes. The companies whose works, systems, franchises, property and assets were thus transferred are: Perry Electric Light Co.; Warsaw Gas & Electric Co.; Dansville Gas & Electric Co.; Yates Electric Light & Power Co.; Hornell Electric Co.; Wayne Power Co. Arrangements were made to finance proposed new construction.



General view of the Oak Grove development

Department of Public Works Approved by Architects

The American Institute of Architects, it is announced, will join with the F.A.E.S. and other engineering organizations in a nation-wide movement to bring about the reorganization of the Department of the Interior as provided in the Brown Plan, which had the approval of the late President Harding.

Grand Rapids Heating Plant to Use Venturi Type Stacks

The new heating plant of the Consumers Power Co. in Grand Rapids, Mich., which is being erected, will have stacks of the Evase or venturi type. There is to be one of the stacks on each of the four boilers to be installed. At the present time two have been erected. The chimneys reach an elevation of 105 ft. above the street and consist of steel funnels, cone shaped and convergent at the base and cone-shaped and divergent at the top. It is claimed that these installations at the Grand Rapids heating plant are the first application to high-capacity boilers in this country.

Ford Motor Co. Completing New Turbo-Generators

Construction of the first of eight new 62,500-hp. turbo-generators to be installed in the Ford Motor Co.'s power house at River Rouge is 85 per cent completed. The test run is scheduled for January. The second unit is 15 per cent under way.

With all units now planned in place, the Rouge power plant will be capable of producing one-half million horsepower, taking its place among the greatest plants of its kind in the world. This enormous power production, according to present plans, will be used entirely for Ford industries and the electrification of the Detroit, Toledo & Ironton Railroad.

The story of the design and building of the big turbines and generators entirely in the Ford shops will be an especially important chapter in the history of Ford activities. The task of making the turbines was undertaken more than a year ago, following the installation of two 12,500-kw. units made by an outside firm. Engineers and machinists who helped to develop Ford automobile production methods and successfully handled the turbine manufacture for war-time "Eagle" boats, undertook the work. To furnish steam for the new turbines, three

additional powdered-coal burning boilers have been installed and a fourth is near completion.

Paper Industries Exposition To Be in April

The Second Paper Industries Exposition will be held at the Grand Central Palace, New York City during the week of April 7. Replies from letters sent to machinery and supply companies in regard to securing space have been most encouraging, according to the management.

Winner of Guessing Contest at Power Show Announced

The guessing contest as to the weight of the exhibit of the Walworth Manufacturing Co. was won by P. R. Robinson, New Brighton, N. Y. The winner is to receive three Walworth Stillson wrenches of 8, 10 and 14 in. The correct weight of the exhibit was 11,904 pounds and the estimate submitted by the winner was 11,875 pounds.

Southern California Edison Co. Orders 30,000-kva. Condensers

The Southern California Edison Co., one of the largest power companies on the Pacific Coast, has ordered from the Westinghouse Electric and Manufacturing Co. three 30,000-kva. synchronous condensers with direct-connected exciters and nine 11,661-kva. step-down transformers with starting taps for the synchronous condensers. The condensers have a maximum capacity of 35,000 kva. and are therefore the largest in the United States.

Two of the condensers and six of the transformers will go in the Edison Company's Laguna Bell Substation, while the other synchronous condenser with the remaining three transformers will go in the Eagle Rock Substation. This apparatus, while not dulplicate equipment, is similar to apparatus already installed and is being added to facilitate extension of the company's system. It is designed to improve the service and to increase the efficiency of the system by lightening the present load on the transmission lines and thus considerably increasing their present capacity.

Mining Engineers Discuss the Coal Problems

Discussions of coal problems, Dr. George Otis Smith, the Director of the United States Geological Survey, pointed out in the course of remarks before the Washington section of the American Institute of Mining and Metallurgical Engineers, reveal the positions of the lawyer and the engineer. "They are standing together," said Dr. Smith, "but they are back to back—the engineer looking forward and the lawyer looking backward."

Dr. Smith presented four phases of the coal question, which formed the basis of a general discussion among those in attendance. These points were: Waste of resource, waste of labor, waste of capital, waste of transportation.

Dr. Smith made a plea for the use of more engineers in the coal-mining industry and their utilization in connection with labor relationships. The engineer, he pointed out, has come up in a part of the work that has placed him in close personal contact with the mine worker. As a result he knows him in a personal way and frequently is better qualified to deal with labor problems than is the mine manager, who often rises to his position through the accounting department. He believes that labor can be brought to a much higher plane of efficiency and expressed the hope that the matter of individual productivity would find a part in the program of labor leaders. He mentioned that he had heard long discourses by labor leaders, but had been impressed by their failure to mention the need of increased efficiency. He expressed decided disapproval of any plan that has as its object the limitation of individual output.

O. P. Hood, chief mechanical engineer of the Bureau of Mines, declared that there are many inheritances of the days of dollar coal which must be overcome. Management must pay more attention to the boiler room, he pointed out, under the changed conditions of higher fuel costs. He expressed the opinion that there is too much imitation in engineering. One engineer will get a desirable result and others will follow like sheep. Mechanical equipment for the handling of coal must be suited to the individual problem rather than that met with in another plant. He urged more study of the combustion problem.

Walter Trent called attention to the fact that at least 90 per cent of the values in ore are recovered at metal mines. Each ton of coal, he said, contains $14.50 of value, but the recovery is less than 20 per cent.

H. Foster Bain, the director of the Bureau of Mines, made the point that control over development would do more than any other single thing to solve the difficulties of the coal industry, but that such a policy would be entirely contrary to the principles that the American people always have supported. Public opinion would not submit to any drastic step looking to limitation of the opening of new mines.

Engineering Institute Announces Program

The Engineering Institute of Canada has announced the tentative program for its annual meeting, to be held in Montreal Jan. 22 and Ottawa Jan. 23-24, as follows:

Wednesday — Registration and reports. Luncheon, at which Chateau Laurier, Governor-General of Canada, will be present and Walter J. Francis will speak. In the afternoon the newly elected president will be inaugurated and an address on "The Fuel Problem" will be given by Dr. Charles Camsell, Deputy Minister of Mines. A banquet and smoker will be given in the evening.

Thursday — Professional meeting. The "St. Lawrence Waterway Problem," by D. W. McLachlan; "The Baby Aëroplane," by Lt. Col. C. W. Stedman; Luncheon; "The Centenary of the Rideau Canal"; "Biography of Colonel Bye, the Engineer," by Hammett P. Hill. In the afternoon there is to be a visit to Deschenes and in the evening a ball.

Brooklyn Engineer to Head Refrigerating Association

The annual convention of the National Association of Practical Refrigerating Engineers at Memphis, Tenn., Dec. 12 to 15, 1923, was the most successful of the fourteen meetings held since the Association has been in existence. A total of over 500 delegates registered and the attendance at the several sessions often ran above that number.

The papers read before the convention were of an intensely practical nature. Some of the more important ones, including "Evaporating Systems," by W. F. Davis; High-Speed Compressor Valves," by J. J. H. Voss; "Ammonia Condensers," by Thomas Shipley; "Operation of the Absorption Systems," by G. A. Pardee; "The Amount of Ammonia Required for Initial Charge," by J. Laichinger, will appear in future issues of *Power*.

The officers chosen for 1924 were: E. J. McCormick, Brooklyn, N. Y., president; William F. Davis, Memphis, first vice-president; Basil S. Dobree,

Mechanical Stokers Sold from January to December 1, 1923

(According to the Bureau of Census)

Month	Number of Establishments Reporting	Stokers sold — Number	Stokers sold — Horsepower	Installed Under — Fire-tube Boilers — Number	Fire-tube Boilers — Sq.Ft. Heating Surface	Water-Tube Boilers — Number	Water-Tube Boilers — Sq.Ft. Heating Surface
January	15	145	83,270	29	34,000	116	798,700
February	15	129	66,619	9	11,720	120	654,470
March	15	120	68,955	9	12,590	111	676,960
April	15	167	85,339	14	20,000	153	833,390
May	15	194	100,513	14	19,150	180	985,980
June	15	135	59,719	6	8,040	129	589,150
July	15	129	52,518	21	34,540	108	490,640
August	15	135	71,693	18	26,240	117	690,690
September	15	99	60,486	16	27,540	83	577,320
October	15	88	32,576	14	23,300	74	302,460
November	15	50	16,241	10	13,000	40	149,410
Total		1,391	697,929	160	230,120	1,231	6,749,170

New Orleans, second vice-president; Edward H. Fox, Chicago, re-elected secretary; Charles W. Chapman, Detroit, Mich., treasurer, re-elected; L. H. Turba, Chicago, sergeant-at-arms; Erle Ormsby, St. Louis, re-elected chairman of the board of directors; H. R. Halterman, Chicago, re-elected chairman educational and examining board; Victor H. Becker, St. Louis, chairman convention program committee; Schribner Page, Boston, Mass., chairman committee on standards; A. J. Authenreith, Chicago, re-elected chairman committee on engine room records; Edward H. Fox, Chicago, re-elected chairman committee on publicity, and C. L. Whittemore, St. Louis, re-elected chairman committee on exhibits.

New Orleans was by unanimous vote given the privilege of entertaining the 1924 convention.

Salt as Coal-Dust Moistener

Tests to determine the value of salt as a moistener for coal dust have been made by the Department of the Interior by placing trays of coal dust in the main entry of the experimental mine of the Bureau of Mines, near Pittsburgh, Pa. Each of the 27 trays used was made to represent a separate test by varying the conditions, either by a difference in the depth of the dust or the method of applying the salt. The temperature and hygrometric state of the air was recorded, and samples of dust were collected from the trays at more or less regular intervals for moisture determinations. Two grades of salt, calcium chloride, and shale dust were used in these tests. A report of the findings will be issued later by the Bureau of Mines.

Fuels Work of the Bureau of Mines

O. P. Hood, in his paper, "Fuels Work of the Bureau of Mines," which he read before the American Institute of Chamical Engineers at its recent convention, outlined the functions of the coal work of the Bureau of Mines and told of its aims as follows:

The greatest good to the greatest number must be kept in mind in choosing direction of effort. So far as may be, the Bureau should interest itself in those investigations of timely fundamental nature and general applicability, that other agencies cannot or will not make.

The Bureau might attempt a house to house campaign to teach the householder the proper use of fuel, and no doubt fuel would be saved and some good would be done, but the effect would be temporary, local and applicable to perhaps one-sixth of the fuel used. Efforts, however, to increase our knowledge of the combustion process and what goes on in a furnace fire, will be continuously applied through generations, and by those designing apparatus using the greater quantities of fuels. To thus have an effect on the problem at the sources of fuel use will be far more potent, although less obvious.

Machinery Markets Formerly Served by Germany

Germany practically is eliminated as a competitor in the sale of machinery in the foreign field during 1924, in the opinion of W. H. Rastall, the chief of the industrial machinery division of the Department of Commerce. As a result his advice to American manufacturers is to take full advantage of this opportunity to extend their operations into those countries once dominated by German manufacturers. "Go in and dig in," is the slogan which he suggests that American machinery manufacturers adopt, as a New Year resolution.

During 1923, despite the adverse conditions arising from abnormally low prices for Latin-American raw materials, machinery exports to those countries from the United States increased 17 per cent. The increase is well scattered among the 95 classifications into which machinery exports are divided. Exports to China have fallen off, but those to Japan and India have increased. World conditions are such as to indicate a considerable expansion in machinery purchases during 1924.

Centrifugal Casting of Cast-Iron Pipes

At the first meeting of the Chicago Section of the American Society of Mechanical Engineers and the Western Society of Engineers held on the evening of Dec. 17, James D. Capron, an engineer of the United States Cast Iron Pipe Co., delivered a most interesting talk on "Centrifugal Casting of Cast-Iron Pipe." A feature of the talk was the showing of an excellent set of films illustrating the old method of making bell-and-spigot cast-iron pipe in sand molds and the new De Levand process of centrifugal casting in water-cooled rotating steel molds. The differences in the two processes were made evident by the pictures. In his talk the speaker gave out comparative data on the physical and metallurgical properties of pipe cast by each method and some interesting results of the tests made to determine the tensile strength, bursting pressure and other properties of the two kinds of pipe. The paper drew a good attendance, and the prolonged and varied discussion following it gave evidence of the interest with which it was received.

Hydro-Electric Plant Planned for City in Greece

A city in Greece has issued detailed plans of a water reservoir and hydro-electric project to be carried out during the coming spring, according to *Commerce Reports*. This project is believed to be among the more serious and worth while to be found in Greece at present and adequate arrangements have been consummated for financing the construction. The plan will involve the impounding of water sufficient to provide for the water supply of a medium-sized city and the erection of a hydro-electric plant for the purpose of supplying light and power to near-by municipalities. Horizontal Francis-type direct-drive turbines are indicated in the plans. It is further stated that three turbine units will be employed of 1,000 hp. each with a normal speed of 1,000 r.p.m. The power factor is given at 0.8 and the line voltage at 8,000 to 8,800.

Accredited American firms may examine detailed plans in the French language regarding construction, mechanical and electrical equipment required, as well as detailed maps, at the district office of the Bureau of Foreign and Domestic Commerce, 734 Customhouse, New York City. The time limit for the submission of tenders expires on Jan. 31, 1924. Reference No. 13282.

During the last two years interest in developing Austria's water-power resources has been very marked. If all the water power available in Austria were exploited, her coal demand of about 15,000,000 tons a year would be decreased to about 8,000,000 tons. Such a reduction would mean much to her balance of trade. Numerous companies have been founded for the purpose of water-power development, partly by private capital and partly by the Austrian Provinces or municipalities. It is said that many years will pass, however, before the idea can be realized. At the present time 3,091 kilometers (1,922 miles) of the natural waterways, having a capacity of 1,128,900 hp., have been worked on, although to date only 109,940 hp. has been actually developed. A full exploitation of all potential water power would result in the production of nearly 3,000,000 hp., according to a U. S. Government report.

New Publications

Elements of Engineering Thermodynamics. By Prof. A. Moyer, Pennsylvania State College, Prof. James P. Calderwood, Kansas State Agricultural College, and Dean Andrey A. Potter, Purdue University. Second edition, Published by John Wiley & Sons, Inc., New York. Cloth; 6x9 in., 224 pages; 75 illustrations; 10 tables and bibliography. Price, $2.50.

As a thorough yet concise textbook on the principles of thermodynamics, the first edition received wide and favorable attention from teachers and practicing engineers. This revision embodies certain changes suggested by the users. The present discussion of heat cycles has awakened a general interest in thermodynamics among graduate engineers who have forgotten much of the subject. For such and others who have a reasonable mathematical equipment, including an elementary knowledge of calculus, this book offers a valuable opportunity for the review of fundamental principles without loss of time on non-essentials. Problems at the end of each chapter

enhance the value of the book both for students and for practicing engineers.

Power Plant Machinery, Vol. I, Mechanism of Steam Engines. By Walter H. James, assistant professor, and Myron W. Dole, instructor, both at Massachusetts Institute of Technology. Second edition. Published by John Wiley & Sons, Inc., New York. Cloth; 6x9 in.; 227 pages; 224 illustrations. Price, $3.

This book does not claim to be a general treatise on steam engines, but merely a study of the kinematics or relative movements of the parts. It was written to meet the needs of students who have studied mechanism, but are unfamiliar with the theory and practice of heat engineering. Most of the space is given to the standard valve diagrams as applied to stationary and locomotive valve gears, but a chapter is devoted to turbine valve gears. While excellently adapted for the teaching of applied kinematics in colleges, the book will be of less value to operating engineers, because it gives little space to the newer types of apparatus.

Coke, Census of Manufacturers, 1921. Department of Commerce. To be purchased from the Government Printing Office, Washington, D. C. Price 5 cents.

"Twenty-mile Park District of the Yampa Coal Fields, Routt Co., Colorado," by Marius R. Campbell. U. S. Geological Survey. Government Printing Office, Washington, D. C. Free.

Trade Standards Adopted by the Compressed Air Society. Published by the Compressed Air Society. Copies to be had from C. H. Rohrbach, 50 Church St., New York City, N. Y.

Water-Power Projects

Osage River Project—Walter Cravens, of Kansas City, has applied for a preliminary permit to construct a dam 100 ft. high on the Osage River eight miles above Bagnell, Mo. The dam will create a pool 125 miles long. The reservoir will cover 65,000 acres. It is proposed to install machinery capable of developing 50,000 hp. The primary power available is 20,000 hp. The entire cost of the project is expected to be $7,500,000. The Burns-MacDonald Engineering Co., of Kansas City, has just reported exhaustively on the project.

Nilgiri Hydro-Electric Project—Some years ago the government of Madras (India) took under consideration a scheme for the installation of a lighting and power plant at a location about nine miles from Octacamund, to provide electric power for the towns of Coonoor, Wellington, Octacamund, and Coimbatore, the last named being the chief center of cotton mills in the southern district of India. Tata Sons & Co. applied for and secured the concession.

The project calls for a dam 120 ft. long across the Kundah River, where a head of about 3,000 ft. can be obtained, and this will form a storage reservoir holding 828,000,000 cu.ft. of water. The potential power is estimated at 20,000 hp. The catchment area provides for 16,000,000,000 cu.ft. for storage, with the result that a normal supply of water is assured throughout the year. All the preliminary details connected with this scheme have been worked out, and will come up shortly for approval by the Madras government, according to *Commerce Reports*.

Coming Conventions

American Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution Bldg., Washington, D. C. Seventy-fifth anniversary meeting at University of Cincinnati, Cincinnati, Ohio, Dec. 27-Jan. 2.

American Engineering Council of the F.A.E.S. L. W. Wallace, 24 Jackson Place, Washington, D. C. Meeting at Washington, D. C., Jan. 10-11.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Midwinter convention at Philadelphia, Feb. 4-8. Spring convention at Birmingham, Ala., April 7-10.

American Institute of Mining and Metallurgical Engineers. F. F. Sharpless, 29 West 39th St., New York City. Annual meeting at New York City, Feb. 18-21.

American Society of Heating & Ventilating Engineers. C. W. Obert, 25 West 39th St., New York City. Annual meeting at New York City, Jan. 22-25.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting, at Cleveland, Ohio, May 19-22.

American Society of Safety Engineers. Genevieve S. Wood, 29 West 39th St., New York City. Annual meeting at New York City, Jan. 18.

Engineering Institute of Canada. Fraser S. Keith, 176 Mansfield St., Montreal, Canada. Annual General Meeting at Montreal, Quebec, Jan. 22—Ottawa, Ontario, Jan. 23-24.

Franklin Institute. R. B. Owens, 15 South Seventh St., Philadelphia, Pa. Annual meeting Jan. 16, 1924.

Indiana Engineering Society. Charles Brossman, 1503 Merchants Bank Bldg., Indianapolis, Ind. Annual meeting at Lincoln Hotel, Indianapolis, Ind. Feb. 14-15.

Iowa Engineering Society. Blanche Veig, Acting Secretary, 406 Flynn Bldg., Des Moines, Iowa. Annual meeting at Cedar Rapids, Jan. 29-Feb. 1, 1924.

Master Boiler Makers Association. H. D. Vought, 26 Courtland St., New York City. Meeting at Chicago, May 20-23, 1924.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 11-13, 1924.

National Marine Engineers' Beneficial Association. Geo. A. Grubb, 313 Machinists' Bldg., Washington, D. C. Annual Convention at Franklin Square Hotel, Washington, D. C. Jan. 21-26.

Society of Automotive Engineers, Coker F. Clarkson, 29 West 39th St., New York City. Annual meeting at General Motors Bldg., Detroit, Mich., Jan. 22-25.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, Ill. Eleventh annual convention at Buffalo, N. Y., April 30 to May 2, 1924.

Ottawa River, Quebec—Contract for the construction of a 60,000-hp. hydroelectric development on the Ottawa River at Bryson, Quebec, has been awarded by the Ottawa River Power Co., to Fraser, Brace, Ltd., engineers, Montreal. The total expenditure on this work will be approximately $3,000,000, and it is expected to have the first unit installed by Dec. 1, 1924.

Long Lake Plant of Washington Water Power Company—The fourth unit to be installed in the Long Lake plant of the Washington Water Power Co, which has been built in a narrow gorge of the Spokane River, 35 miles from the city of that name, is to be ready by the first of the new year. It is rated at 22,500 hp. and will bring the capacity of the plant up to 90,000 hp., the figure for which it was constructed. This plant has been built under unusual engineering difficulties at a total cost of about $6,000,000. The spillway is one of the largest in the world.

Lake Cushman Power Project—The construction of the first unit of the Lake Cushman power project proposed by the City of Tacoma, Wash., is provided for in ordinances for the issuance of bonds and letting contracts introduced in the City Council. The ordinance, passed nearly three years ago, which provided for the development of the project, must be amended to suit changes in the plan, and a new ordinance providing for $4,000,000 of light utility bonds is expected to be passed in time for a call for bids some time in the near future.

The Lake Cushman project called for an ultimate development of 140,000 hp. and an expenditure of $10,000,000. The first unit will develop 50,000 hp.

Aberdeen, Wash., Project on Wynooche River—The Grays Harbor Light & Power Co., of Aberdeen, Wash., a concern operated by Sanderson & Porter, of New York, has applied to the Federal Power Commission for a preliminary permit covering a project in the Wynooche River at a point 25 miles above Aberdeen. It is planned to build a dam 150 to 170 ft. high. A conduit is to be run to a power house where 10,000 hp. will be developed. The site of the reservoir is covered with a heavy stand of timber. It will be a number of years before it will be cleared, but the power company has been forced to put in its application by the action of the municipality of Aberdeen in voting a bond issue of $2,000,000 looking to this very development.

Society Affairs

The Milwaukee Section of the A.S.M.E. will hear Fred. R. Low, the newly elected president of the Society, speak at its Jan. 16 meeting.

The Washington, D. C., Section of the A.I.E.E. announces that Major J. Franklin Bell, Engineer Commissioner of the District of Columbia, will give a short address at a noonday luncheon on Jan. 23 at the City Club.

The Chief Engineers' Association of Chicago, at the usual annual election selected officers for the ensuing year: F. J. Young, president; F. Erlenborn, vice-president; C. W. Gilmore, past-president; E. V. Smedes, recording secretary; W. H. Couch, financial secretary; C. H. Langs, treasurer; W. Butler, conductor; William Metcalf, doorkeeper.

The Metropolitan Section of the A.S.M.E. will have as the subject of its Jan. 22 meeting, "Coal Storage—Work of the Metropolitan Coal Storage Committee of the F.A.E.S." Robert M. Gates, of the Locomotive Superheater Co., will speak, and George C. Titcomb, McMyler International Co., will deliver a paper on "Coal Storage Handling Equipment."

Business Notes

The Southwestern Engineering Co. announces that it has removed its offices from 50 Church St. to 90 West St., New York City.

The Kerr Turbine Co. announces the appointment as district sales manager of L. D. Howland, who is located at 606 Howard St., San Francisco, Cal.

J. E. Rhoads & Sons, leather belting manufacturers, 35 North Sixth St., Philadelphia, Pa., announce the opening of a new store at 68 South Forsyth St., Atlanta, Ga.

The Chicago Pneumatic Tool Co. announces that the General Machinery Co., of Spokane, Wash., is its agent for the eastern part of the State of Washington and northern part of Idaho.

The General Electric Co., Schenectady, N. Y., announces that Nicholas M. DuChemin has assumed the duties of general superintendent of its West Lynn plant following the death of William J. Lloyd on Oct. 28.

Trade Catalogs

Refractories — Laclede-Christy, St. Louis, Mo. Bulletin describing firebrick.

Engine, Troy—Troy Engine & Machine Co., Troy, Pa. Bulletin H shows construction details of this new Troy type SH small, vertical engine.

Cranes—Whiting Corp., Harvey, Ill. Bulletin describing and illustrating the use of different types of cranes for use in the power house.

Traps—Fulton Foundry & Machine Co., Cleveland, Ohio. Bulletin showing the construction and dimensions of these high- and low-pressure steam traps.

Baffles—Power Plant Efficiency Co., 314 Balwin Bldg., Indianapolis, Ind. Bulletin "The Answer!" gives a description of interlocking sectional tile baffles for use in Stirling, Badenhausen, Connelly and boilers of similar construction.

Pumps, Centrifugal—De Laval Steam Turbine Co., Trenton, N. J. Catalog "Centrifugal Pumps" has 72 pages of illustrations and explanatory text regarding these single and multistage pumps.

Compressor, Air—Sullivan Machinery Co., Peoples Gas Bldg., Chicago, Ill. Bulletin covering specifications for angle-compound belt-driven air compressor, class WJ-3, is well illustrated and shows details as well as installations.

Refractories—The Maphite Corp., 608 South Dearborn St., Chicago, Ill. Catalog "Maphite, The Natural Refractory for Bonding, Filling, Surfacing in Power Plant Service," describes, with illustrations, the method of application and use.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Dec. 17, 1923	Dec. 24 1923
Pool 1	New York	$3.25	$3.25
Smokeless	Columbus	2.25	2.00
Clearfield	Boston	2.25	2.25
Somerset	Boston	2.50	2.50
Kanawha	Columbus	1.75	1.75
Hocking	Columbus	2.00	2.00
Pittsburgh No. 8	Cleveland	2.00	1.90
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.75	3.50
West Ky.	Louisville	2.00	1.90
S. E. Ky.	Louisville	2.00	1.75
Big Seam	Birmingham	2.15	2.15

New York—Dec. 27, light oil, tank-car lots, 28@34 deg. Baumé, 4c. per gal., 36@40 deg. 4¼c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Dec. 18, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70; 28@30 deg., $1.15; 32@36 deg., gas oil, $1.85 per bbl.; 36@40 deg., distillate, $1.95@2.00 per bbl.

Pittsburgh—Dec. 17 f.o.b. local refinery, 30@34 deg., fuel oil, 4⅜c. per gal.; 36@40 deg., fuel oil, 5c.; 34 deg., neutral 8c. per gal.

Dallas—Dec. 20, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Cincinnati—Dec. 24, tank-car lots, f.o.b. local refinery, 26@30 deg. Baumé, 5c. per gal.; 30@32 deg., 5¼c.; 38@42 deg., distillate, 6½c. per gal.

Philadelphia—Dec. 22, 28@30 deg., $1.57½@1.62½ per bbl.; 18@22 deg., $1.47@1.51½; 13@16 deg., $1.36½@1.40½ per bbl.

Chicago—Dec. 8, 24@26 deg., $1.62 per bbl.; gas oil, 32@36 deg., $1.97 per bbl.

Boston—Dec. 18, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 6⅜c. per gal.

New Plant Construction

Ark., Dumas—The Stimson Lumber Company, Memphis, Tenn., has tentative plans for the construction of a steam power plant at its proposed local saw and lumber mill on property recently acquired, estimated to cost $130,000.

Ark., Malvern—The Van Veneer Co., will purchase a generator and auxiliary equipment, motors, controls and other power apparatus for installation at its proposed local mill, estimated to cost about $90,000.

Ark., Little Rock—The Arkansas Granite Co., recently formed with a capital of $150,000, plans for the construction of a power house at its proposed granite quarries in this vicinity. W. P. Barr, Little Rock, is president and general manager.

Calif., Alhambra—The American Liquid Meter Co., recently organized, C. H. Warner, San Gabriel, Cal., vice-president, plans for the construction of a power house at its proposed local plant in the vicinity of Orange Street and Fremont Avenue, estimated to cost $100,000.

Calif., Riverside—The Southern Sierras Power Co., has authorized immediate work for the construction of a hydroelectric power plant on the Owens River Gorge, Mono County, with capacity of 13,400 hp., estimated to cost $500,000.

Calif., Riverside—The National Ice & Cold Storage Co., will commence the immediate erection of a two-story addition to its cold storage department, estimated to cost about $43,000, with equipment. G. T. Roberts is general manager.

Calif., San Francisco—The Board of Public Works will receive bids until Jan. 9, for butterfly valves for use in connection with the penstock lines for the Mocassin Creek power plant of the Hetch Hetchy municipal power project, consisting of three primary valves, each 104 in. inside dia., and auxiliary appurtenances, as per specifications on file at the office of the city engineer, Third Floor, City Hall. Estimated cost, $40,000.

Calif., Santa Monica—The Common Council has authorized plans for extensions and improvements in the waterworks plant and system, estimated to cost $1,000,000, including equipment. Olmsted & Gillelen, Hollingsworth Building, Los Angeles, are engineers.

Calif., Watts—The R. E. Borbeck Co., Los Angeles, Cal., has tentative plans for the construction of a power house at its proposed local tile manufacturing plant on site recently acquired, estimated to cost $75,000.

Conn., Stamford—The Pine Waste Products Co., Inc., contemplates the construction of a power house at its proposed new pulp and paper mill on site soon to be selected in Georgia. The project will mature in about 60 to 90 days.

Conn., Waterbury—The Waterbury Lumber Co., 60 Meadow Street, is completing plans for the construction of a two-story steam power house on Benedict Street. Thomas M. Freney, 51 Leavenworth Street, is architect.

D. C., Washington—The Board of District Commissioners, District Building, will receive bids until Jan. 12, for one boiler, return tubular, self-contained, in steel casing, with fire brick lining.

D. C., Washington—The general purchasing officer, Panama Canal, will receive bids until Jan. 11, for air compressor, electric motor, switchboard, transformers, and other equipment for canal zone service, as specified in Circular 1581.

Fla., Fort Pierce—C. J. Ryan, city manager, will receive bids until Jan. 9, for one electrically-operated, distilled water ice-manufacturing plant with capacity of 20 tons per day, for city service.

Fla., St. Petersburg—Wood Brothers, Graham, Tex., are perfecting plans for the construction of an ice-manufacturing and

cold storage plant, 125 x 140 ft., on local site recently acquired, estimated to cost $200,000, with equipment.

Ga., Austell—The Austell Cabinet Co., recently organized to construct and operate a local furniture factory, is in the market for an engine, boiler and auxiliary power house equipment. Motors and other kindred apparatus for factory service will also be purchased. A. B. Harrington is head. W. F. Collier is construction engineer, in charge.

Ga., Columbus—The Empire Mills have tentative plans for enlargements in their ice and cold storage plant, to include the installation of additional equipment. F. A. Heard is president.

Ga., Savannah—The Lehigh M. White Co., is in the market for an engine, pump and auxiliary apparatus for waterworks installation.

Ida., Nampa—The Common Council is considering preliminary plans for the construction of a steam-operated municipal electric power plant, to cost close to $85,000.

Ill., Chicago—The Great Lakes Shipbuilding Corporation, 308 South Wabash Avenue, plans for the construction of a power house at its proposed speed boat manufacturing plant on the North Branch of the Chicago River, estimated to cost $155,000. George S. Nimmons & Co., 122 South Michigan Avenue, engineers, have preliminary plans in progress.

Ind., Seymour—The City Council plans for the installation of electric pumps and auxiliary equipment at the proposed sewerage plant, for which plans will be prepared by C. H. Hurd, Indianapolis, Ind., engineer. It is estimated to cost $240,000.

Ind., Shelbyville—Harold and Charles P. Sindlinger, Shelbyville, are having plans prepared for the construction of a one-story cold storage plant on local site, estimated to cost $35,000.

Iowa, Clinton—The City Council plans for the construction of a power and pumping plant on Wallace Avenue, in connection with a proposed sanitary sewerage system, estimated to cost $1,500,000. It is expected to call for bids in the spring. Benton R. Anderson, Weston Building, is engineer.

Ky., Flemington—The Neon Ice & Ice Cream Co., plans for the purchase of equipment for a proposed local ice-manufacturing plant, for which site and building will soon be arranged.

Ky., McAndrews—The Little Pond Coal Corporation plans for the installation of power equipment and mining machinery at its local properties. A list of apparatus will be prepared by H. G. Happersett, Roanoke, Va., R. F. D. No. 3, treasurer and construction engineer.

Ky., Middlesboro—The City Council will install an electric-operated pumping plant in connection with a new sanitary sewerage system, estimated to cost $500,000. J. C. Richardson is city engineer.

Ky., Owensboro—The City Council has authorized plans for extensions and improvements in the municipal lighting and power plant, estimated to cost $100,000. W. M. Watson is engineer, in charge.

La., Pitkin—The Board of Education plans for the construction of an isolated electric lighting plant for service at the proposed local high school. F. W. Steinman & Son, Beaumont, Tex., are engineers.

Me., Fairfield—The Central Maine Power Co., has tentative plans under consideration for the rebuilding of its local power plant. F. W. Mason, Waterville, Me., is engineer.

Md., Aberdeen—The Puritan Brick Co., recently formed with a capital of $225,000, plans for the construction of a steam power plant at its proposed local brick works, estimated to cost close to $100,000. Mechanical drying equipment will also be installed. George Hays Mitchell is one of the heads of the company.

Md., Baltimore—The Maryland Glass Corporation, Mount Winans, plans for the installation of a power house at its new local glass manufacturing plant, for which construction will soon commence.

Mass., Haverhill—The Haverhill Electric Co., will commence extensions and improvements in the engine department at its local power plant on Water Street, including the installation of additional equipment. Charles H. Tenney & Co., 200 Devonshire Street, Boston, Mass., are engineers.

Mass., Hopedale—The Draper Corporation is having plans drawn for the construction of a power plant at its local textile mill. John A. Stevens, Lowell, Mass., is engineer.

Mass., Quincy—The Granite Railroad Co., has rejected bids for its proposed new one-story compressor house, and will take new estimates at a later date on revised plans. It will cost about $22,000. Daniel D. Merrill, 5 Beekman Street, New York, is architect.

Mich., Detroit—The Pittman & Dean Co., Farwell Building, will take bids at once on separate contracts for the construction of a one-story ice-manufacturing plant on Mack Avenue, 100 x 250 ft., estimated to cost $200,000, including equipment. The George B. Bright Co., Marquette Building, is architect.

Miss., Meriden—The City Council plans for the installation of electric pumping machinery at the waterworks in connection with proposed extensions and betterments to cost $80,000. A bond issue is being arranged.

Mo., Plattsburg—Davinia & Coleman, Weston, Mo., have plans under way for the construction of a local ice-manufacturing plant, on site lately purchased, estimated to cost approximately $40,000.

Neb., Dannebrog—The Common Council plans for the installation of an electric-operated pump at the proposed municipal power plant, for which bonds for $21,750 have been approved. Harold Hald is clerk.

Neb., Fremont—The Common Council is planning for a bond issue of $100,000, for the installation of a sewerage disposal plant, including electric pumping machinery. Plans will be drawn at an early date.

N. J., Salem—The Congoleum Co., Inc., Morris Building, Philadelphia, Pa., plans for the construction of a power house at its new local plant for the manufacture of linoleum products, estimated to cost $110,000, for which work will soon commence.

N. J., Westwood—The Village Council plans for the installation of electric-operated pumping equipment in connection with a sewerage disposal plant and system, for which preliminary plans are now being prepared. Thomas F. Bowe, 110 William Street, New York, is consulting engineer.

N. Y., Carthage—The United Battery Corporation, John J. Wetmore, president, has tentative plans for the construction of a power house at its proposed local plant at Washington and Cemetary Streets, estimated to cost about $100,000, for which it is expected to ask bids in the spring. Gustave Koehler, 6-A North Hamilton Street, Poughkeepsie, N. Y., is engineer.

N. C., Andrews—The City Council has disposed of a bond issue of $350,000, for the installation of a municipal electric plant.

N. C., Asheboro—The Common Council, Arthur Ross, mayor, will receive bids until Jan. 10, for a 250 g.p.m. and 750 g.p.m. centrifugal pumps; gate valves, steel tank and auxiliary equipment for waterworks extensions and betterments. The J. B. McCrary Engineering Co., Atlanta, Ga., is engineer.

N. C., Asheville—The Sayles Finishing Plants, Inc., Saylesville, R. I., will build a power house at its proposed local textile mill on site recently acquired, estimated to cost $2,000,000. Mill machinery will be electrically operated and motors, controls and kindred apparatus will be installed. Work will soon commence.

N. C., Kinston—The Washington Gas Co., Washington, N. C., plans for the construction of a steam power plant at its proposed local artificial gas works, estimated to cost $100,000, including equipment.

N. C., North Wilkesboro—The Town Council will ask for bids early in Jan. for an electric generating station, using oil-operated engine, with complete equipment, for waterworks service. The Carolina Engineering Co., Southern Building, Wilmington, N. C., is engineer.

N. C., State College (Raleigh P. O.)—The Board of Trustees, North Carolina State College, has approved an appropriation of $55,000, for the construction of a power house at the institution, for which plans will be prepared at an early date.

N. D., Bismarck—The City Council has tentative plans in preparation for the construction of a power house at the city hospital, with stack 125 ft. high. The Frank Tustison Co., 130 Auditorium Building, Minneapolis, Minn., is engineer.

Ohio, Willard—Arrangements are being perfected for the early appointment of an engineer to prepare plans for a municipal electric power plant, estimated to cost $100,000. C. J. Robinson, councilman, is chairman of the special light plant committee, in charge.

Ohio, Toledo—The Standard Oil Co., will install power equipment, stills, tanks, piping, pumps and kindred equipment in connection with proposed additions to its local oil refinery, estimated to cost in excess of $2,500,000.

Okla., Beggs—The Beggs Ice Co., recently organized, has tentative plans under advisement for the installation of a local ice-manufacturing plant. Fred Sullivan heads the company.

Okla., Stillwater—The Common Council plans for the installation of electric pumping machinery and auxiliary equipment at its proposed waterworks. V. V. Long & Co., Colcord Building, Oklahoma City, Okla., are engineers.

Ore., The Dalles—The Common Council is planning for the installation of pumping equipment for waterworks service.

Ore., Klamath Falls—The California-Oregon Power Co., San Francisco, Calif., will commence the construction by day labor of its proposed hydro-electric power plant on the Link River, for which bids recently were rejected. It will have an initial capacity of 4500 hp., and is estimated to cost close to $500,000. Machinery requirements will be arranged at an early date.

Pa., Erie—George C. Gensheimer, secretary, Commissioner of Public Works, will receive bids until Jan. 23, for the design, construction and erection of a triple expansion, fly wheel and condensing pumping engine, with capacity of 20,000,000 g.p.d., according to plans on file, and also on file at the office of J. N. Chester, Union Building, Pittsburgh, Pa., consulting engineer.

Pa., Shadeland—An electric and steam power plant will be constructed at the proposed new local steel mill, estimated to cost in excess of $3,000,000, for which plans are being prepared by the Bradley Co., Jones Law Building, Pittsburgh, Pa., engineer. A new company is being formed to build and operate the plant.

S. C., Andrews—Morris & Co., Georgetown, S. C., have plans for the construction of a local ice-minufacturing plant with initial daily output of about 25 tons, estimated to cost $55,000. John Morris is manager.

S. C., Newberry—The City Council has authorized plans for waterworks extensions and improvements, including the installation of a high service pumping plant, electrically-operated, and a raw water pumping station. A bond issue of $125,000 has been approved. P. H. Norcross, Atlanta, Ga., is consulting engineer.

S. C., Wadesboro—The Muriel Lumber Co., recently organized with a capital of $100,000, is in the market for an engine, boiler and auxiliary equipment for a power house at its proposed local mill. L. D. Robinson is president.

S. D., Rapid City—The South Dakota State Cement Commission, C. A. Hunt, secretary and treasurer, plans for the construction of a power house in connection with a proposed local cement mill, estimated to cost in excess of $150,000. The J. C. Buckbee Co., 38 South Dearborn Street, Chicago, Ill., is engineer.

Tenn., Memphis—The Fisher-Hurd Lumber Co., recently organized as a subsidiary of the Fisher Body Co., General Motors Building, Detroit, Mich., has tentative plans for the construction of power plants in connection with mill expansion in Tennessee, Arkansas and Louisiana. O. P. Hurd, Memphis, is president.

Tenn., Memphis—The Hoshall Machinery Co., P. O. Box 187, plans for the purchase of a 150 kw. generator, direct-connected to automatic engine, and auxiliary equipment.

Tex., Alto—The Alto Light & Power Co., is planning for the rebuilding of the portion of the boiler house at its local plant recently destroyed by fire. An official estimate of loss has not been announced.

Tex., Dallas—The Texas & Pacific Railroad Co., Texas & Pacific Building, has tentative plans for the construction of a steam power plant at its proposed local shops in the Belt Junction service, estimated to cost $750,000.

Tex., Refugio—The Pratt-Hewitt Syndicate will install air compressors and steam power equipment at its proposed carbon black manufacturing plant, estimated to cost $250,000.

Va., Farmville—The Common Council is disposing of a bond issue of $50,000, to be used for a municipal lighting plant, including equipment.

Va., Richmond—The Hackley-Morrison Co., 1708 Lewis Street, is in the market for a Scotch type boiler, about 250 to 300 hp., and for two horizontal return tubular boilers, 150 hp. each. Also, for motors, 75 and 100 hp., and a mechanical extractor for laundry service, 18 to 20 in.

W. Va., Huntington—The Huntington Ice Co., has tentative plans for the installation of additional equipment at its ice and refrigerating plant.